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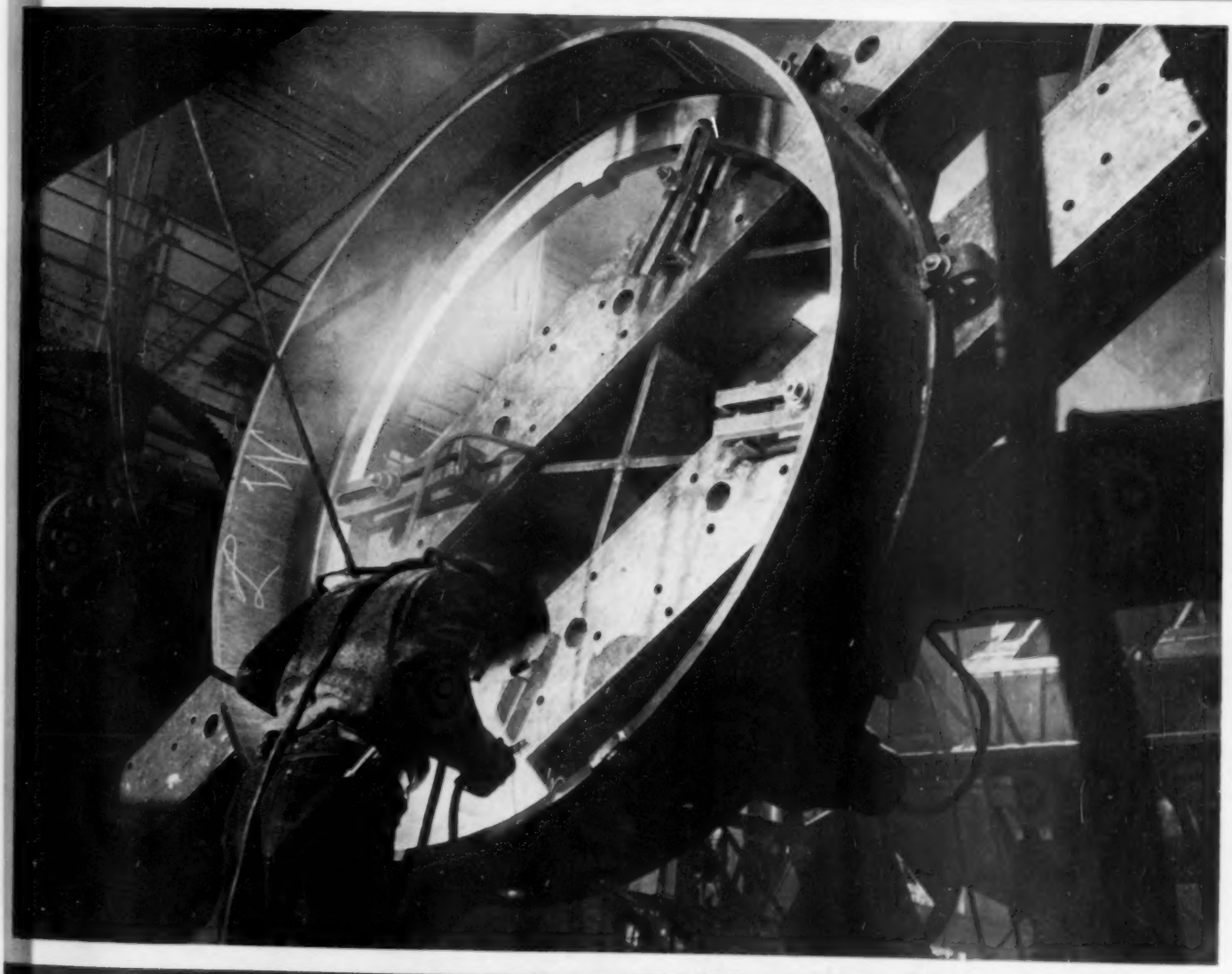
# The WELDING Journal



The Journal of the American Welding Society

# Now..for Welding

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1. Self-contained units. Can be added to control equipment in the field.
2. Quick-warming tubes. . . . No time delay. . . . No time delay relays.
3. No change in circuits to install.
4. Individual control for each weld in Hydromatics and Ultra-Speeds in one unit.
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6. Longer useful life of Ignitrons (higher capacity firing tubes).

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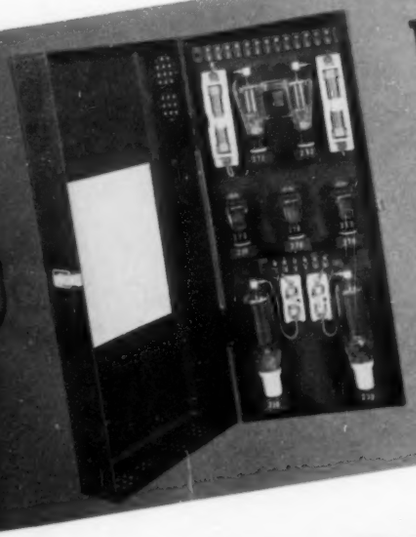

1. Positive Welding Control on BOTH half-cycles (positive and negative half-cycles individually controlled).
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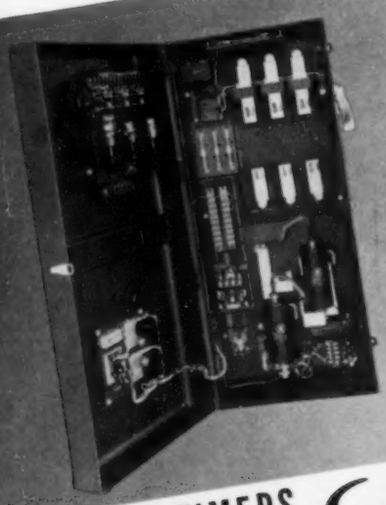

1. All welding machine controls in one compact cabinet.
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3. Custom assembled for each job from standard Weltronic control units.
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**The Journal of**

**The American Welding Society**

**VOLUME 21 • NUMBER 1 • JANUARY, 1942**

# Survey of Welding and Cutting in Ship Construction*

## With Special Details of Automatic and Mechanized Procedures

By F. G. Outcalt and J. M. Keir†

THIRTY thousand men will be engaged in welding and cutting in our country's shipyards this year according to recent estimates. If we assume that 24,000 of these men will be employed as welding operators and that each will deposit metal at an average rate of 20 lb. per shift, the quantity of metal deposited daily adds up to some 480,000 lb. In thinking of such numbers of men and the dependence which the shipbuilding industry places upon them and upon the welded joints they produce, we cannot help remembering that as recently as 1935, many a shipbuilder mistrusted welding as a means of joining hull plating and other essential structural parts of a ship, and would have none of it.

Although a few nearly all-welded ships were built prior to 1936, the strongest real impetus to the welding of self-propelled ocean-going vessels was provided that year when the Sun Shipbuilding and Dry Dock Company built the virtually all-welded 521-ft., 18,500-ton tanker *J. W. Van Dyke* for the Atlantic Refining Company. An important feature of this construction was the use for the first time anywhere in shipbuilding of the then new Unionmelt automatic electric welding process.

Although the adoption of welding eliminated much of the layout work formerly required in the shipyard mold loft and greatly simplified the preparation of steel for the ship, the cutting of plate edges for welding is as important as proper shearing and punching for riveted construction. Accurate preparation is necessary not only for structural reasons but for economic reasons. Lap joints can, of course, be used without accurate sizing of plate, but welded lap joints are uneconomical in plate, add useless weight to the ship, increase welding costs and complicate the details of construction. They are seldom used except when welding is applied as the method of joining on a structure that was originally designed to be riveted.

Welded construction, therefore, led to a careful consideration of plate-edge cutting; and since plate planers are costly to install and cannot be quickly obtained, attention naturally focused on flame-cutting equipment for cutting and beveling plate edges. The advantages of flame cutting for plate-edge preparation over planing,

Fig. 1

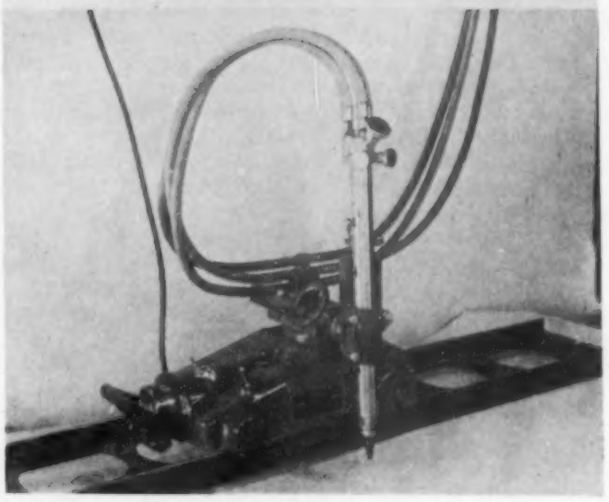


Fig. 2

* Paper presented at the Annual Meeting, A. W. S., Philadelphia, Pa., October 20 to 24, 1941.

† Engineers, The Linde Air Products Company, New York, N. Y.

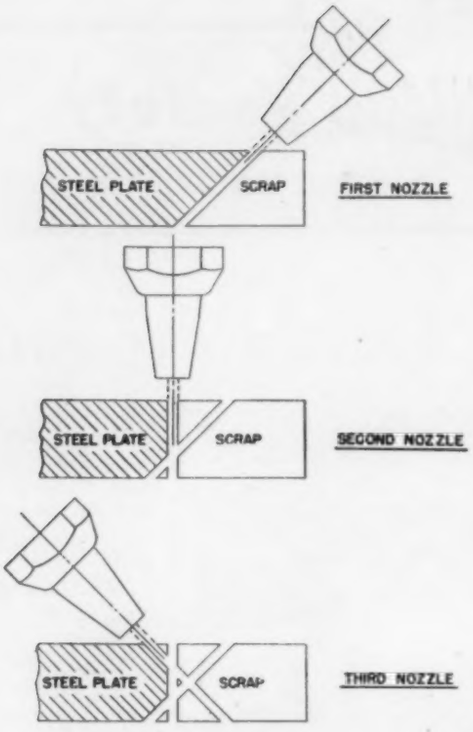



Fig. 3

particularly at the present time of great shipbuilding activities, can therefore be summarized as follows:

1. High speed of production.
2. Availability of equipment.
3. Low cost of equipment.
4. Low cost of power.
5. Low investment charges on equipment since major operating charges are for labor and consumable materials used only during production.

The cutting flames impose no external loads on the plate, and therefore heavy holding clamps, large tool-driving motors and massive installation foundations are not required. The hand-operated cutting blowpipe cannot be satisfactorily used for any but the shortest seams, since manual guiding causes irregular edges and bevels. Though such irregularly fitted edges can be welded, the sacrifices in welding speed and the cost of extra weld metal and labor required more than outweigh the apparent convenience of manual torch cutting. Much of the plate preparation for welding is now done with blowpipes mounted on small, portable, motor-driven carriages which travel in straight or curved paths on portable track or directly on the plate.

Figure 1 shows one unit which can be guided by track or can be accurately steered by the operator to make cuts almost equal to those obtainable with track guidance.

Figure 2 shows another type of carriage-mounted blowpipe unit which is generally used on track.

Many of the early types of these machines carrying one blowpipe are still in use for cutting plain square edges or single-beveled edges, and are sometimes used for cutting more complicated edge preparations by means of two or three passes of the single blowpipe. However, accuracy is difficult to obtain in this manner of multi-pass cutting because the tendency of each successive heating and cooling to warp the plate is cumulative, and compensation or correction is practically impossible.

A more advanced procedure of plate-edge preparation involves the use of two or three blowpipes or specially connected cutting nozzles so adjusted that the two or three surfaces are cut during one passage of the machine. The most complicated edge preparation of any commonly used for welding is the double-bevel with unbeveled root face. The sequence of cuts for this kind of edge preparation made during one pass of the machine having three closely spaced cutting nozzles is illustrated in Fig. 3. This operation is more economical of gases than the making of three similar but separate cuts in three passes, and the total heat effect tending to distort the plate is but little greater than the heat effect of a single cut.

If bevels are to be cut with their top and bottom edges truly straight, the ends of the blowpipe nozzles must travel at exactly uniform distances from the plate surfaces as well as in a plane perpendicular to the plate and parallel with the finished edge. A blowpipe rigidly connected to a carriage traveling on a straight track cannot properly bevel anything but a perfectly flat plate. The heavy machine tool plate planer is designed to hold the plate firmly in a flat position, but since one of the desirable advantages of flame cutting is the lightness of the equipment, it proved easier to arrange for the blowpipes to rise and fall so that the distance between nozzles and plate surface would remain constant at all times, even when cutting a wavy plate.

An example of this type of cutting machine is shown in Fig. 4. The cutting nozzles are attached to the lower end of the vertical shaft which is free to move up and down in accurately fitting roller bearings. The weight of the floating assembly is supported on a wheel riding directly on the plate surface adjacent to the cut. Depth of bevel and contour of cut on the plate edge are always uniform in relation to the surface on which this supporting wheel rides.

When long cuts are to be made with this type of equipment, it is essential that the track on which the blowpipe carriage operates be straight and level. Obviously, straight cuts cannot be made from a track that is less than straight, and since the machine is designed for cutting plate at a position below the level of the track, any variations in the relative elevation of the two rails would tilt the carriage and move the cutting nozzles out of the desired plane of travel. To provide and

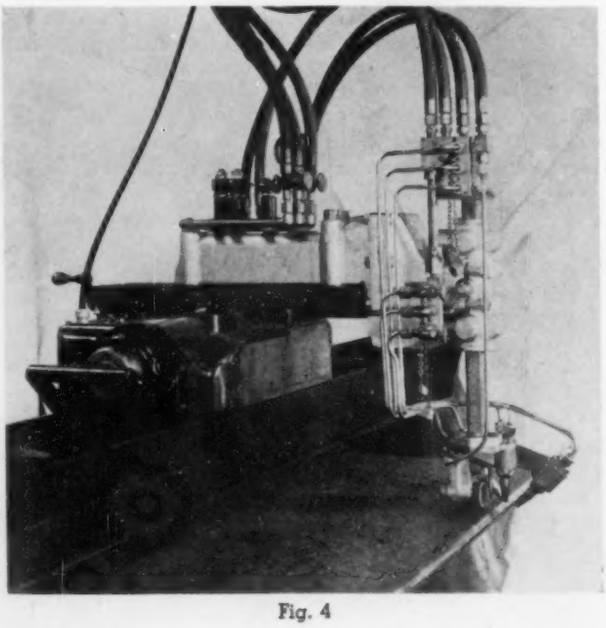


Fig. 4

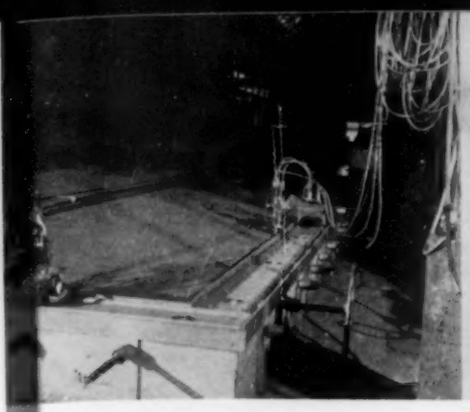


Fig. 5

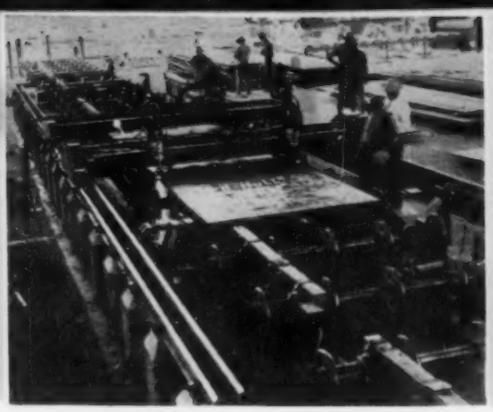


Fig. 6

Fig. 7

maintain accurate track alignment, it is necessary to have firm foundations and rigid track mounting.

In some shipyards, a single straight section of track is installed on a permanent mount. The plate must be accurately positioned for cutting and turned after each cut to bring a new edge to the line of cutting. The total time required to prepare edges with this equipment is, of course, the sum of the time required to make the individual cuts around the full periphery of the plate, plus the time for positioning. In other yards, plate handling time and cutting time have been reduced by using an L-shaped track with two machines, one traversing each leg of the L. In this way, two cuts are made at the same time without changing the position of the plate.

Figure 5 shows an arrangement of such an L-shaped cutting track and the plate supports. A number of schemes have been suggested for supporting the plate, and pillar supports with or without casters to permit the easy positioning of plate can be used.

If all the plates to be cut were approximately of the same size, a four-track arrangement could be used, but this has not been found practical and a better arrangement is now in use which still further mechanizes flame plate-edge preparation. This machine, the name of which has been partly taken from the plate planer which it replaces, is called the "Flame Planer."

This machine, shown in Fig. 6, makes use of the same type of carriages and the same arrangement of cutting nozzles as are used in the single track and L-track installations, but it requires crane service only for the delivery and removal of the plates. This machine also makes possible a reduction of the total time of cutting any plate to approximately that required for making the longest cut, and minimizes layout measuring and manual labor. As shown in Fig. 6, the flame plate-planer consists of three separately controlled, closely coupled, roll table conveyors over which the cutting machines travel on movable bridges. On the three separately controlled roller table sections, the plates are received, cut and discharged. The plates move from one section to the next on the live, motor-driven rollers of the conveyor table controlled through conveniently located push-buttons.

At the cutting section, mechanical means, controlled at a central point, are provided for aligning the plate and holding it in position during the cutting operation. At both sides of the cutting bed are accurately positioned rails on which operate the movable bridges carrying the cutting equipment. For the simultaneous cutting of four edges of a plate, three bridges are provided.

The middle one of the three is electrically driven by a variable speed motor and gear reduction assembly, and carries two cutting units which make the longitudinal edge preparations and are easily adjustable to any position on the span across the roll table by means of a crank-operated feed screw. Floating mountings for the cutting heads, similar to those used in carriages previously described, are also used on these units so that the cuts will follow any waves in the plate.

The two end bridges carry the mechanism for trans-

**Time and Gas Consumption and Production Data**

| Plate Thickness, In. | Type of Edge Preparation | Approximate Time and Consumption of Gases per 10 Linear Ft. of Plate Edge: Cutting Time, Min. | Gas Consumption in Cu. Ft.: Oxygen | Gas Consumption in Cu. Ft.: Acetylene | Approximate Operating Time for Plates of Different Lengths, Min.*: 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/16 | Square edge | 6 | 7 | 1.0 | 9.5 | 11 | 12 | 13.5 | 14.5 | 16 | 17 | 18 | 19.5 |
| | Single 30° bevel | 6 | 9 | 1.4 | 9.5 | 11 | 12 | 13.5 | 14.5 | 16 | 17 | 18 | 19.5 |
| | Single bevel and nose | 7 | 12 | 2.2 | 11.5 | 13 | 14 | 15.5 | 17 | 18.5 | 20 | 21 | 22.5 |
| | Double bevel and nose | .. | .. | ... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 1/2 | Square edge | 7 | 9 | 1.2 | 11.5 | 13 | 14 | 15.5 | 17 | 18.5 | 20 | 21 | 22.5 |
| | Single 30° bevel | 7 | 16 | 1.7 | 11.5 | 13 | 14 | 15.5 | 17 | 18.5 | 20 | 21 | 22.5 |
| | Single bevel and nose | 8 | 19 | 2.5 | 13 | 14.5 | 16 | 18 | 19.5 | 21 | 22.5 | 24 | 25.5 |
| | Double bevel and nose | 9 | 36 | 6.4 | 14.5 | 16.5 | 18 | 20 | 22 | 23.5 | 25.5 | 27 | 29 |
| 3/4 | Square edge | 8 | 16 | 1.5 | 13 | 14.5 | 16 | 18 | 19.5 | 21 | 22.5 | 24 | 25.5 |
| | Single 30° bevel | 8 | 21 | 2.1 | 13 | 14.5 | 16 | 18 | 19.5 | 21 | 22.5 | 24 | 25.5 |
| | Single bevel and nose | 9 | 44 | 4.3 | 14.5 | 16.5 | 18 | 20 | 22 | 23.5 | 25.5 | 27 | 29 |
| | Double bevel and nose | 9 | 48 | 6.4 | 14.5 | 16.5 | 18 | 20 | 22 | 23.5 | 25.5 | 27 | 29 |
| 1 | Square edge | 9 | 19 | 1.7 | 14.5 | 16.5 | 18 | 20 | 22 | 23.5 | 25.5 | 27 | 29 |
| | Single 30° bevel | 9 | 24 | 2.4 | 14.5 | 16.5 | 18 | 20 | 22 | 23.5 | 25.5 | 27 | 29 |
| | Single bevel and nose | 10 | 56 | 5.0 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |
| | Double bevel and nose | 10 | 61 | 8.3 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |

* Cutting of long edges governs overall cutting time. Since both of these are made simultaneously by movement of the same carriages, the time of travel of this carriage is equal to the overall production time of cutting all four edges of a plate.

verse cutting of the plate. These end bridges are not motor driven but are provided with ball-bearing wheels for easy movement to any desired position along the main side rails, and can be quickly locked securely in place. On each of these bridges is mounted a standard motor-driven carriage like those pictured in Fig. 4. Any of these units can be fitted with nozzle blocks carrying one, two or three nozzles for cutting a straight, square edge, a single bevel, a single bevel with unbeveled root face, a double bevel or a double bevel with an unbeveled root face. The desired edge contour is, of course, finished in one single passage of the group of cutting flames along the plate. Since the adjustment of all the moving parts of the machine can be accurately maintained or quickly duplicated, a number of exactly similar plates can be cut very rapidly. Furthermore, the adjustments of the machine are so easily made that little time is required even if each plate is of different dimensions. Plates with curved edges and plates of irregular shape can also be cut by means of special attachments for the machine or by manual operation of the positioning controls.

Table 1 presents some production data based on the actual operation of this machine in a West Coast shipyard.

It is noteworthy that even for the most complicated double-vee- and square-root-face preparation of one-inch-thick plate, the time required for complete preparation of all edges of a rectangular piece is only one minute per foot of longest plate dimension.

The development of an accurate and rapid method of plate-edge preparation was fostered to a great extent by the development of rapid methods of welding and the consequent need for accuracy in plate alignment for butt-joint assemblies. It was not until the need for this alignment accuracy for automatic electric welding focused attention on edge preparation that the great advantages of accurate and uniform fitting of plate edges for manual arc welding were fully appreciated. Unfortunately, there are still many shipyard men who are unwilling to insist on careful edge preparation because they think costs will be increased. Actually the net total cost is usually decreased because of the savings in welding expense made possible by the elimination of poorly fitted joints.

Manual electric arc welding is the method by which the largest proportion of all ship welding is accomplished. It is virtually the only method used for welding vertical seams or where welding must be done "overhead" on the underside of a seam. For much of the "downhand" welding, where weld metal is deposited in seams on a virtually horizontal surface, manual arc welding is also used, particularly where the seams are short, are difficult to reach, or are in relatively thin material which can be welded completely in one or two passes. Much of the downhand arc welding is done with electrodes developed during the past few years which can be used

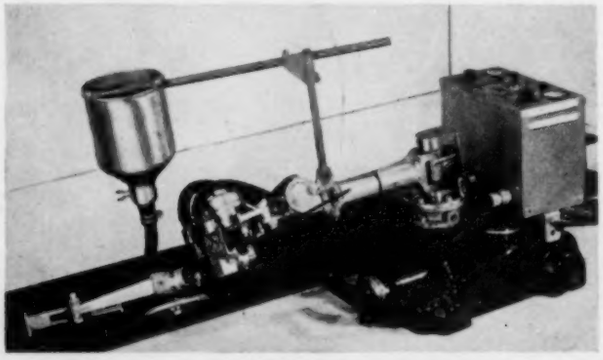
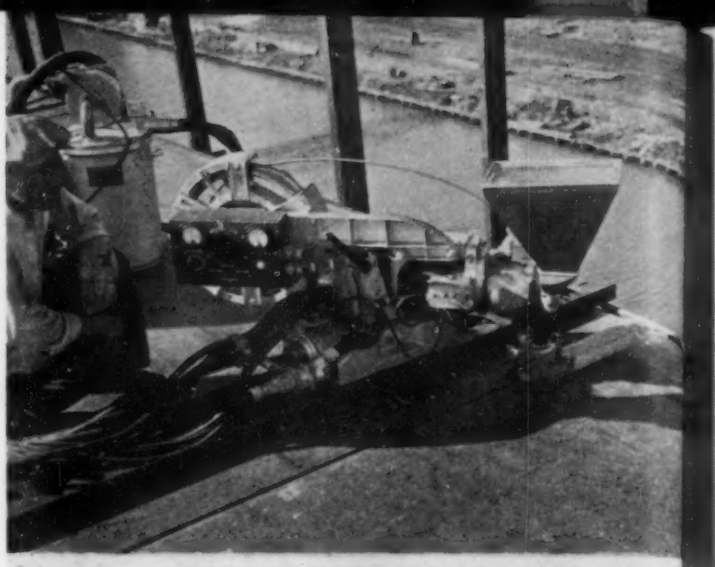
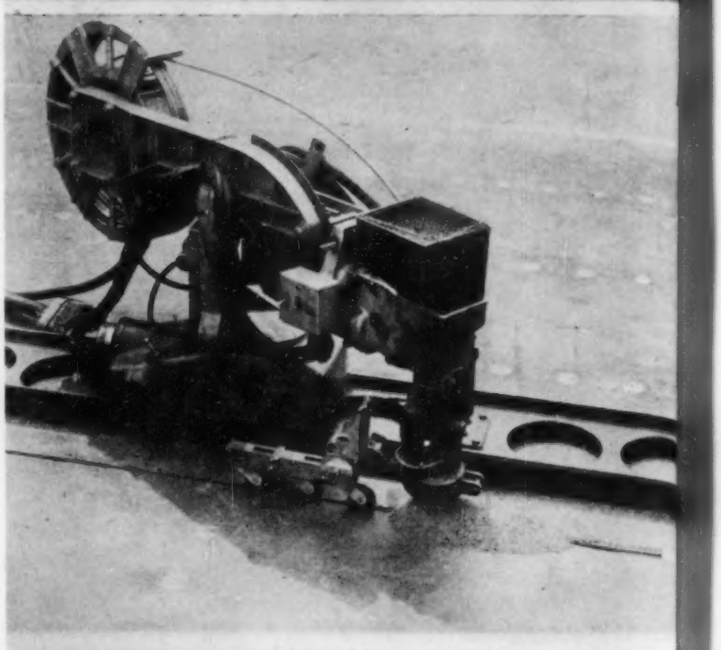
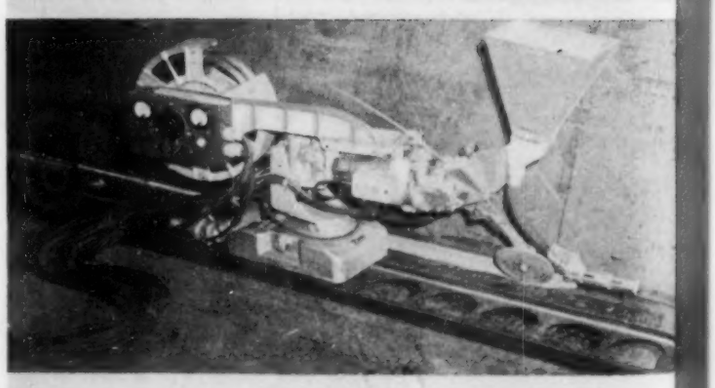
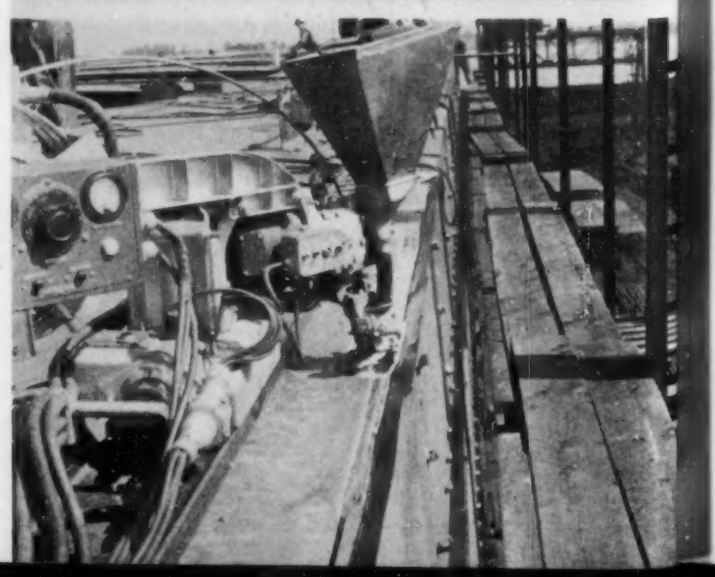


Fig. 8









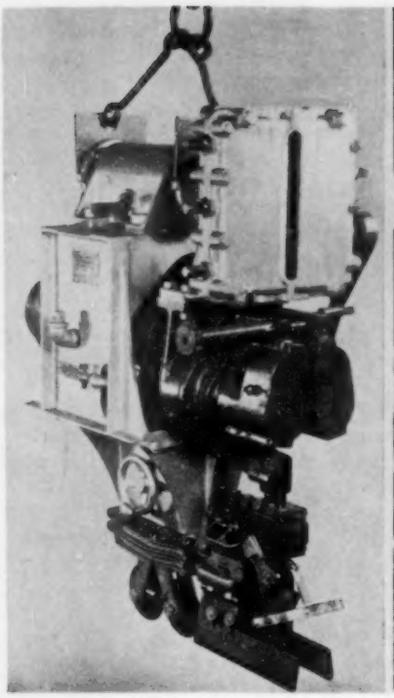


Fig. 13

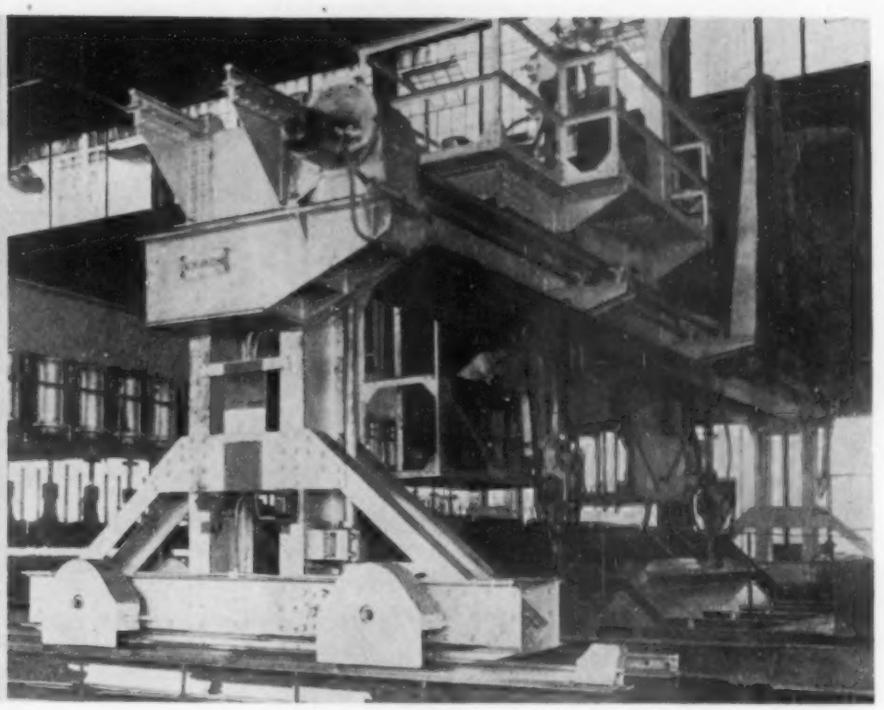


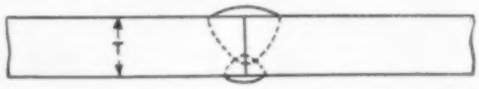
Fig. 14

with higher currents than the previously used electrodes. With these so-called "hot" electrodes, metal can be deposited at high rates without as great losses of electrode in spatter and vaporization as would occur if high currents are used with ordinary electrodes. Current densities as high as 9000 amp. per sq. in. are recommended for these electrodes instead of the practical limit of approximately 6000 amp. per sq. in. for the "all position," "cold" electrodes.

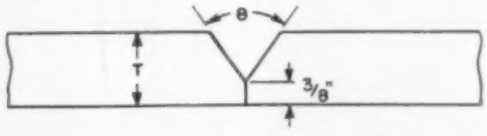
This tendency toward more widespread use of the high-current electrodes has caused a decided trend toward higher capacity welding units such as the 400- and 600-amp., single operator, DC generators, the 500- and 750-amp. AC transformers and the larger multiple-operator units. Multiple-operator units are generally used to supply current to a greater number of operators than would be indicated from the rating of the equipment. Such apparent overloading has developed from experience which shows that because of the diverse activities of a number of operators, only a few are drawing their

**Joint No. 1—Two-Pass Unionmelt Butt Welds***

Joint Backed with Platen or Heavy Structural Shape

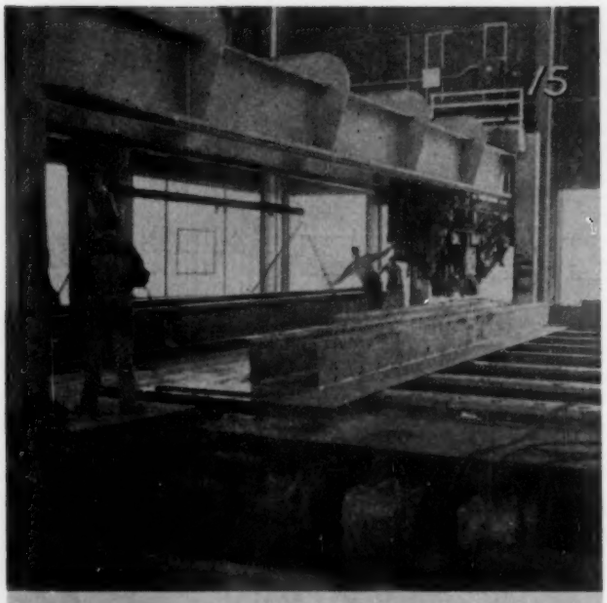


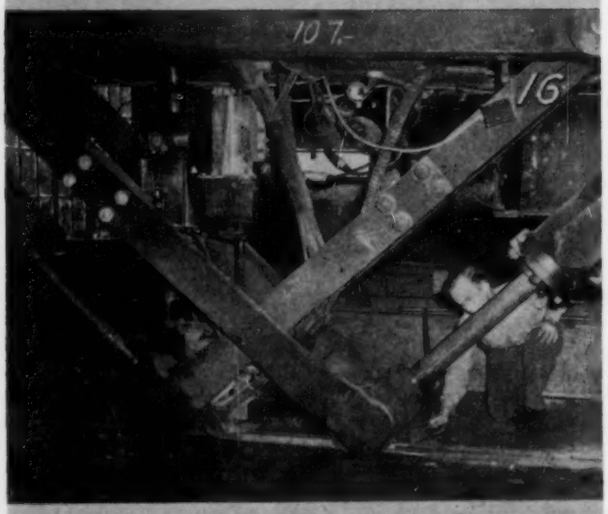

| | Backing Pass | | | | | Finishing Pass | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Thickness, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Lb./Ft. | Amp. | Volts | Speed, In./Min. | Welding Rod Diam., In. | Lb./Ft. | Total Vee Angle θ, ° |
| 1/4 | 400 | 32 | 28 | 5/32 | 0.10 | 500 | 30 | 27 | 5/32 | 0.12 | |
| 5/16 | 420 | 32 | 28 | 5/32 | 0.11 | 550 | 30 | 26 | 5/32 | 0.15 | |
| 3/8 | 500 | 32 | 28 | 3/16 | 0.14 | 600 | 32 | 24 | 3/16 | 0.18 | |
| 7/16 | 600 | 33 | 24 | 3/16 | 0.20 | 700 | 35 | 22 | 3/16 | 0.25 | |
| 1/2 | 700 | 33 | 22 | 3/16 | 0.23 | 750 | 35 | 20 | 3/16 | 0.27 | |

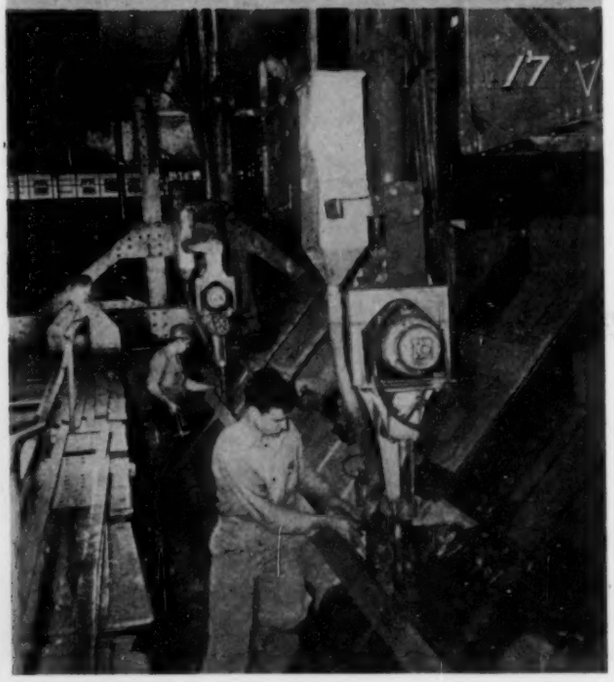



| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/16 | 650 | 33 | 22 | 1/4 | 0.21 | 900 | 31 | 20 | 1/4 | 0.38 | 90 |
| 5/8 | 650 | 33 | 22 | 1/4 | 0.21 | 950 | 31 | 18 | 1/4 | 0.44 | 90 |
| 3/4 | 700 | 33 | 22 | 1/4 | 0.23 | 1000 | 33 | 16 | 1/4 | 0.50 | 75 |
| 7/8 | 700 | 33 | 22 | 1/4 | 0.23 | 1100 | 35 | 14 | 1/4 | 0.60 | 60 |
| 1 | 700 | 33 | 22 | 1/4 | 0.23 | 1200 | 35 | 12 | 1/4 | 0.75 | 45 |

* Used for keel plating seams, tank tops, tweendecks, bulkheads, etc.




maximum required current at one time. Sometimes as many as 100 operators can be served by a machine of 5000-amp. capacity, even though each operator may sometimes use 200 or 300 amp. while actually welding.

Of the estimated 24,000 welding operators employed by the fifty or so Navy and private yards on the Coasts and Great Lakes, about 1000 to 1500 are using oxyacetylene welding equipment for the welding of brass, copper, aluminum and other special materials used in the equipment of ships. Much of the service piping is also oxyacetylene welded. Oxyacetylene heating is used for pipe bending and for straightening and correcting buckling which sometimes results from the welding of ship hulls, decks and superstructures. By far the greater number of all welding operators, however, are engaged in manual arc welding.

An estimated 800 men, however, are operating automatic electric welding equipment with which they can deposit metal at a much higher rate of speed than is possible with manual arc-welding equipment. These men, an operator and a helper to each special machine, are depositing metal by the Unionmelt welding process, welding with current densities in their welding rod of from 14,000 to 30,000 amp. per sq. in., and feeding steel welding rod through their equipment at rates of from about $^1/_3$ lb. per minute to about 1 lb. per minute, depending upon the thickness of steel being welded.

Because of the high current density and the high rate of heat input into the weld, there are several things about the preparation for welding and the Unionmelt welding procedure which are unusual. In some yards, butt welds $^3/_8$ in. deep are being made in one pass in plate that is square-butted tightly together without any beveled preparation. When beveling is used, the vees are smaller and the amount of metal required to complete the joint is much less than that required for the other welding methods commonly used by shipbuilders. Therefore, the $^1/_3$ lb. to 1 lb. of rod melted per minute generally produces two to three times as much length of welded seam as would be produced with an equal weight of electrode used in other electric welding processes.

In spite of the high current densities used in Unionmelt welding, no excess heat is introduced into the joint because of the high speeds. Furthermore, the deep penetration of a single pass gives more uniform heating of the entire thickness of the joint and reduces the tendency to bowing of the welded pieces. Obviously, the fewer the number of passes, the less the cumulative shrinkage effect. Most types of joints are assembled for Unionmelt welding by simply butting them tightly together. All of these factors combine to eliminate the need for appreciable overall allowances for shrinkage of the automatic high-current, high-speed welds.

With this process there is no flashing arc to be seen. In fact, while the welding is going on, there is normally nothing to indicate even at close view that perhaps 30 to 90 kw. of electrical energy are being transformed to heat, that welding rod is being melted at formerly unheard-of rates, and that almost twice as much base metal as added rod metal is being fused to form a homogeneous, deeply penetrated weld.

The medium which makes this possible is a granulated material of special properties which is fed by gravity through the welding head and laid along the seam to sufficient depth to cover completely the welding zone and the end of the bare steel welding rod.

Except for the forward movement of the welding head, Fig. 7 shows all there is to see of the welding action. The unfused granulated Unionmelt is shown covering the completed weld for about a foot to the right of the welding zone. Further to the right, the unfused mate-

**Joint No. 2—Melt-Backed Unionmelt Butt Welds**

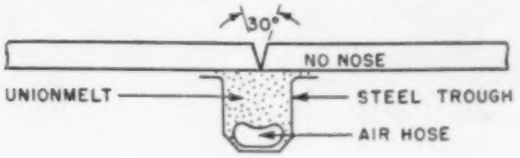



**Table I**

| Thickness, In. | Edge Preparation | Ampere | Volts | Speed, In./Min. | Welding Rod Diam. In. | Welding Rod Lb./Ft. | Air Pressure Lb./Sq. In. |
|---|---|---|---|---|---|---|---|
| 1/4 | Square | 960 | 42 | 38 | 1/4 | 0.15 | 70 |
| 5/16 | Square | 960 | 42 | 36 | 1/4 | 0.17 | 70 |
| 3/8 | 30° vee, no nose | 900 | 40 | 32 | 1/4 | 0.20 | 65 |
| 7/16 | | 920 | 37 | 26 | 1/4 | 0.26 | 65 |
| 1/2 | | 960 | 37 | 22 | 1/4 | 0.33 | 60 |
| 9/16 | | 960 | 35 | 20 | 1/4 | 0.36 | 55 |
| 5/8 | | 1020 | 35 | 18 | 1/4 | 0.44 | 50 |
| 3/4 | | 1080 | 35 | 15 | 5/16 | 0.53 | 45 |
| 7/8 | | 1160 | 35 | 10 | 5/16 | 0.91 | 45 |
| 1 | | 1250 | 35 | 8–9 | 5/16 | 1.15 | 45 |

Above tabulated conditions provide reinforcement or flat bead on backs of welds.

**Table II**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1/4 | Square | 700 | 32 | 21 | 1/4 | 0.22 | 35 |
| 5/16 | Square | 720 | 32 | 21 | 1/4 | 0.25 | 35 |
| 3/8 | Square | 760 | 32 | 18 | 1/4 | 0.33 | 35 |
| 7/16 | 30° vee, no nose | 800 | 32 | 17 | 1/4 | 0.37 | 35 |
| 1/2 | | 860 | 32 | 17 | 1/4 | 0.40 | 35 |
| 9/16 | | 900 | 31 | 17 | 1/4 | 0.45 | 35 |
| 5/8 | | 960 | 31 | 14 | 1/4 | 0.55 | 35 |
| 3/4 | | 1020 | 33 | 10–12 | 5/16 | 0.69–0.83 | 35 |
| 7/8 | | 1150 | 34 | 9–10 | 5/16 | 0.91–1.01 | 35 |
| 1 | | 1200 | 34 | 8 | 5/16 | 1.17 | 35 |

Above tabulated conditions provide flat to grooved backs on welds.
In both of the above cases backing melt is 3 1/2 in. deep above a 3 1/2-in. diameter fire hose.

rial has been removed and the fused portion of the Unionmelt is shown slightly lifting away from the surface of the finished weld as both weld and solidified melt cool. The unfused material can be retrieved for re-use.

There is much variety in the equipment used in shipyards to take up the unfused granulated Unionmelt. The simple dust-brush and pan used in some yards is less common than some form of "vacuum-cleaner" type of equipment. Such mechanical equipment must be specially designed to withstand the action of the highly abrasive material or vulnerable parts must be cheap enough to make frequent replacement economical.

The welding head shown in Fig. 7 is a simplified, "stripped" unit suitable only for feeding straight lengths of welding rod for making welds requiring not over approximately 1000 amp. of welding current, which is about that required for making a fully penetrated weld 1/2 in. deep. This type of machine is simply constructed and easily portable. Figure 8 shows a complete unit of this type and of the latest design mounted especially to permit adjustment for making unpositioned fillet welds.

The welding units of the type shown in Fig. 9 feed rod from coils of approximately 25 lb. weight and are used for making welds requiring up to about 2000 amp. Welds of about 1 1/4-in. thickness can be made in one pass with this machine. The equipment can be readily moved about on flat surfaces but must usually be handled by crane for longer moves.

In Fig. 10 the machine is shown welding a deck butt joint. The arrangement of this machine shown in Fig. 11 was especially designed for fillet welding where guiding must be accurate with provision for following any waviness in the plate. The same type unit is shown in Fig. 12 making the corner butt joint between the spar deck and shear strake of a Great Lakes ore freighter. At the left, in this picture, behind the arc-welding generator are shown the four 500-amp. welding transformers which are connected in parallel to supply the welding current to the automatic welding machine.

Most yards use 1000-amp. transformers either singly or connected in parallel; 440- or 220-v., 60-cycle, single-phase current is generally supplied to the welding transformers, although a few installations use 2300-v. supply sources.

A few welding heads are supplied with direct current from standard welding generators. Regardless of the source of current, provision is made to make and break the supply current instantaneously at full load for starting and stopping a weld. A contactor operated from a small switch on the welding head is standard equipment. The contactor to control the welding current may be in the primary supply lines to the welding transformers, in the output circuit of DC generators, or, if the generator field circuits can be isolated, a small contactor in the field circuit will suffice.

A large, heavy type of welding head which is in no sense portable was the first one used with Unionmelt welding. This head, illustrated in Fig. 13, must be mounted on a substantial supporting structure. It is capable of feeding as much as 4000 amp. of welding current to welding rod as large as 1/2 in. in diameter.

Two of these large heads were installed in 1936 in the shipyard in which Unionmelt welding units were first used in shipbuilding. Since that time, many of the smaller units and additional large heads have been put in service in that yard. The highly developed methods

of construction at that yard, and the use of large auxiliary mechanical equipment especially designed for mass production of tankers, have led to a greater use of automatic welding than is found in any other shipyard. Figures 14 and 15 show a part of the installation of the large automatic welding equipment, and Figs. 16 and 17 show closer views of welding with the large heads.

In all other yards, only the smaller, portable units have been used and good results are being obtained. At the present rate of expansion of use, there will probably be 1500 men using these automatic welding machines in another year.

The use of this process in shipbuilding has been, and will be even more in the immediate future, an important factor in speeding welded construction. One operator and a helper can produce from 200 to 400 ft. per 8-hr. day of finished seam in steel of average ship-plate thickness. Hence the use of this process releases many an arc-welding operator for the greater amount of welding which on any ship is not adaptable to automatic machine methods.

Prefabrication is the principal field of application of the Unionmelt welding process, although in many yards the machines are taken onto the ways for the welding of shell bottom plating, tank tops and decks. The prefabrication includes the welding of sections of tank tops, shell plating, bulkheads, shaft alleys and decks, as well as sections of superstructure, and king posts and booms of cargo-handling equipment.

Butt welds and fillet welds are the types principally made. Smaller fillets of less than about $^3/_8$-in. leg dimension are frequently made without positioning the pieces, but the large fillets tend to sag, and the pieces must usually be tilted so that the diagonal surface of the weld will be approximately horizontal.

In the making of butt welds, full advantage of the deep penetration of Unionmelt welding and its consequent capacity to weld considerable thicknesses in one pass cannot be taken unless some means are provided for supporting the molten metal from the under side. Several methods of backing welds and of combining manual arc welding and automatic Unionmelt welding are indicated in the tables of data for various types of joints used in shipbuilding.

Both types of Joint 1, illustrated, require tightly fitted edges to prevent the weld metal from flowing through, but for plate thicknesses less than $^1/_2$ in., contact with a platen or structural members on which the subassembly is laid is usually needed for additional chill to control the fluid metal.

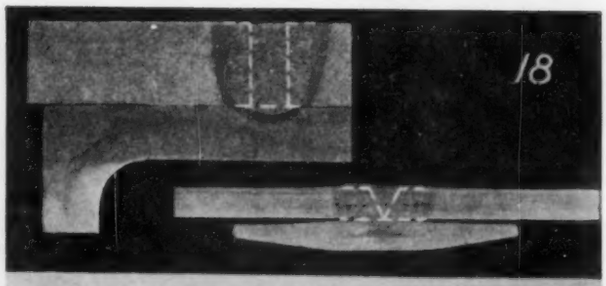
The edges must be straight and fitted tightly enough to exclude a shipfitter's feeler. If mill-sheared edges are used, it may be necessary to grind or otherwise condition the edges to obtain this result.

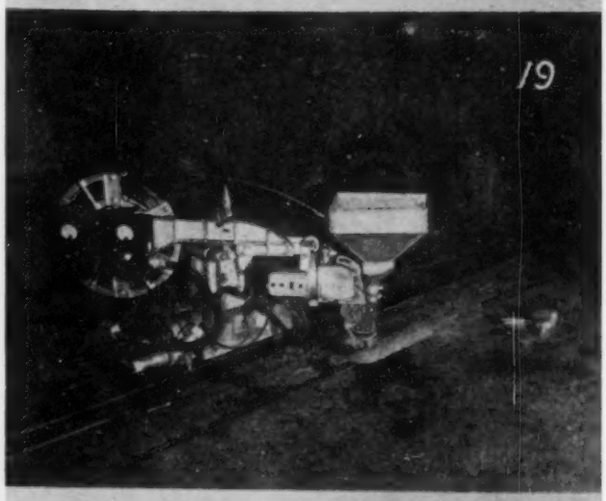
The weight of the plates assembled on a platen is usually sufficient to maintain satisfactory contact, but it may be necessary to hold them down by weights, roller or structural means.

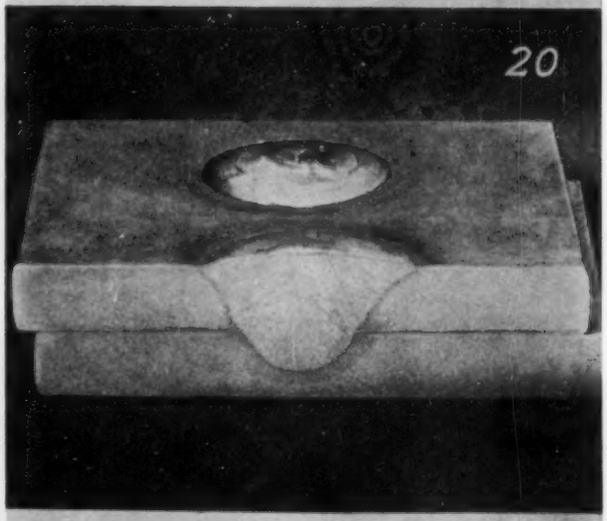
Joint 3 requires uniformly close and tight contact between the underside of the seam and the copper-backing to prevent the weld from running out.

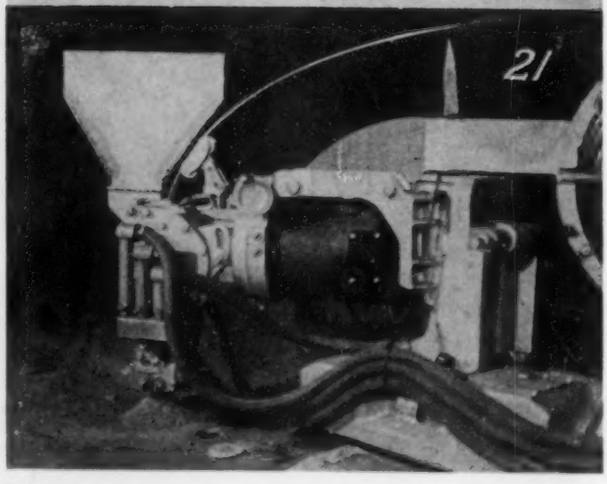
Uniformly sound welds require removal of all surface scale, rust and other material so that clean metal is exposed on the surfaces in contact with the copper-backing-up means.

In Joint 4 the manual welds replace the initial Unionmelt weld of Joint 1. The manual weld must be sound, uniformly reinforced and of a depth (measured by penetration plus reinforcement) at least one-half the plate thickness for plates up to $^1/_2$ in. thick in order adequately

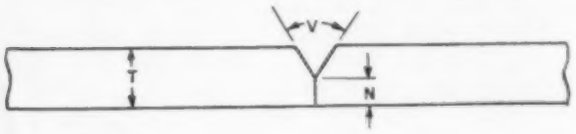


**Joint No. 3—Copper-Backed Unionmelt Butt Welds**




| Thickness, In. | Vee, ° | Nose, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam. In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|---|---|
| 3/16 | 60 | 1/8 | 500- 575 | 28-31 | 29-35 | 3/16 | 0.11-0.13 |
| 1/4 | 60 | 1/8 | 725- 825 | 29-32 | 28-31 | 3/16 | 0.14-0.23 |
| 5/16 | 60 | 1/8 | 775- 900 | 30-33 | 26-29 | 1/4 | 0.25-0.30 |
| 3/8 | 60 | 1/8 | 900-1000 | 32-36 | 24-27 | 1/4 | 0.28-0.35 |
| 7/16 | 60 | 1/4 | 1000-1100 | 32-36 | 22-25 | 1/4 | 0.33-0.40 |
| 1/2 | 60 | 3/16 | 1075-1175 | 34-37 | 20-23 | 1/4 | 0.38-0.45 |
| 5/8 | 45 | 3/16 | 1150-1250 | 35-38 | 16-19 | 1/4 | 0.50-0.58 |
| 3/4 | 45 | 3/16 | 1200-1300 | 36-39 | 13-14 | 1/4 | 0.60-0.75 |
| 7/8 | 40 | 1/8 | 1375-1500 | 38-40 | 11-13 | 5/16 | 0.80-0.95 |
| 1 | 35 | 1/8 | 1500-1600 | 39-41 | 10-12 | 5/16 | 0.90-1.10 |
| 1 1/8 | 30 | 1/8 | 1575-1650 | 39-41 | 9-10 | 5/16 | 1.00-1.25 |
| 1 1/4 | 30 | 1/8 | 1600-1700 | 39-41 | 8- 9 | 5/16 | 1.25-1.60 |
| 1 1/2 | 30 | 1/8 | 1900-2000 | 40-43 | 7- 8 | 3/8 | 1.85-2.00 |

to back the finishing Unionmelt weld and assure complete overlapping.

The top manual pass in Joint 4-C should be thoroughly cleaned of slag before Unionmelt welding.

With Joint 5 the steel backing bar should bear uniformly on the underside of the seam in order to prevent fluid metal from running out.

If considerable variation in edge-bevel and edge-distance is encountered, it should be compensated for by variation in welding speed to maintain desired reinforcing. The distances between the edges and the bevels tabulated are the minimum allowable.

If Joints 6 and 7 are not fitted tight, some method of damming the molten metal must be employed so as to prevent a runout.

Cleaning by grinding or wire-brushing of the surfaces to be welded will permit the use of highest welding speeds and help to produce uniformly sound welds.

Procedures differ in detail in various shipyards, but generally the assembly of sections of hull, inner bottoms, bulkheads and deck starts with the laying of the prepared plates on a large platen or on a skeleton table made of T-bars, I-beams or other structural steel shapes. Partly penetrated automatic welds are then made and the stiffeners are fillet welded to the plate which is then turned over and automatically welded from the other side, with ample penetration into the weld previously made from the first side.

Frequently, the hull bottom plates are laid individually on the ways, an overhead weld is made on the underside of the plate by manual arc welding and, with this as backing, a Unionmelt automatic weld is made from above. Similar procedure is often used in applying deck or tank top plating, although sometimes the plate joints land on a flanged structural member or are fitted with a steel backing strip, and a weld with cross sections like that shown in Fig. 18 is made. The scene in Fig. 19 shows typical operation on bottom and deck weldings.

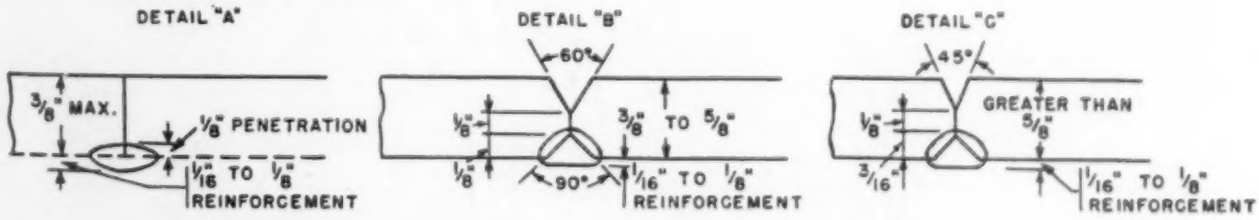
Plug welding is an operation of ship construction for which the Unionmelt process is well suited. Recently one shipbuilder found it was possible to produce as many as 76 plug welds per hour with one portable Unionmelt welding machine, fastening 1/2-in. tank top plating to the flanges of angle-iron supporting structures. Figure 20 shows a typical section of a plug weld and Fig. 21 illustrates the making of plug welds with standard equipment. Simple, light-weight, hand-operated equipment has recently been introduced to facilitate plug welding.

With all methods of welding, cleanliness of plate edges and weldability of material are vital to success. Manual metallic arc welds are often made with fair success but with questionable economy on plate which is wet, oily or dirty. Such conditions, however, are usually not tolerated.

In Unionmelt welding, freedom from gas-forming contaminants in the fusion zone is particularly important

**Joint No. 4—Manual Weld-Backed Unionmelt Butt Welds**

(*A*) Manual Weld Deposited in Downhand Position (Plate Turned Over for Unionmelt Welding)




CONDITIONS FOR UNIONMELT WELDING

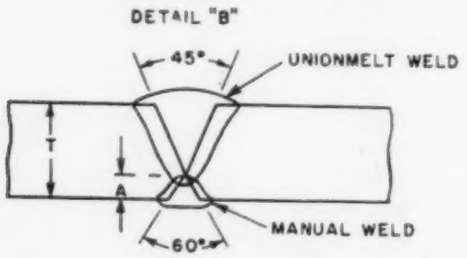
| Thickness, In. | Detail | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|---|
| 3/16 | *a* | 500 | 28 | 27 | 5/32 | 0.12 |
| 1/4 | *a* | 550 | 28 | 27 | 5/32 | 0.13 |
| 5/16 | *a* | 600 | 30 | 26 | 3/16 | 0.15 |
| 3/8 | *a* | 650 | 32 | 24 | 3/16 | 0.18 |
| 7/16 | *b* | 750 | 33 | 22 | 3/16 | 0.25 |
| 1/2 | *b* | 850 | 33 | 22 | 1/4 | 0.30 |
| 5/8 | *b* | 950 | 33 | 20 | 1/4 | 0.37 |
| 3/4 | *c* | 1050 | 35 | 16 | 1/4 | 0.50 |
| 7/8 | *c* | 1150 | 35 | 13 | 1/4 | 0.60 |
| 1 | *c* | 1200 | 35 | 11-12 | 1/4 | 0.80 |

With all methods of welding, cleanliness of plate edges and weldability of material are vital to success. Manual metallic arc welds are often made with fair success but with questionable economy on plate which is wet, oily or dirty. Such conditions, however, are usually not tolerated.

In Unionmelt welding, freedom from gas-forming contaminants in the fusion zone is particularly important

**Joint No. 4—Manual Weld-Backed Unionmelt Butt Welds**

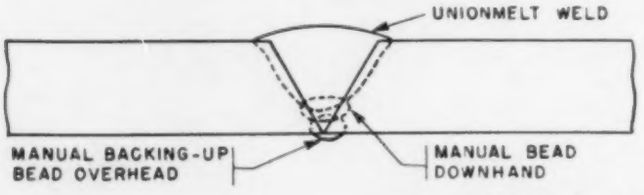
(*B*) Manual Weld Deposited Overhead




| Thickness, In. | Detail | *A*, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|---|---|
| 1/4 | *a* | 1/8 | 550 | 28 | 27 | 5/32 | 0.13 |
| 5/16 | *a* | 1/8 | 600 | 30 | 26 | 5/32 | 0.15 |
| 3/8 | *a* | 5/32 | 650 | 32 | 24 | 5/32 | 0.18 |
| 7/16 | *a* | 5/32 | 750 | 33 | 22 | 5/32 | 0.25 |
| 1/2 | *b* | 1/4 | 850 | 33 | 22 | 1/4 | 0.30 |
| 9/16 | *b* | 1/4 | 900 | 33 | 20–24 | 1/4 | 0.30–0.37 |
| 5/8 | *b* | 1/4 | 950 | 33 | 18–21 | 1/4 | 0.33–0.38 |
| 3/4 | *b* | 1/4 | 1050 | 33 | 14–16 | 1/4 | 0.50–0.57 |
| 7/8 | *b* | 1/4 | 1125 | 35 | 11–12 | 1/4 | 0.65–0.71 |
| 1 | *b* | 1/4 | 1200 | 37 | 9–10 | 1/4 | 0.85–0.95 |

**Joint No. 4—Manual Weld-Backed Unionmelt Butt Welds***

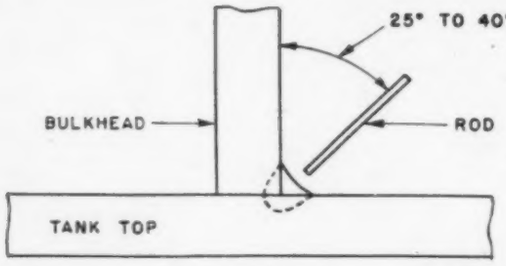
(*C*) Combination Overhead and Downhand Manual Weld Backing




| Thickness, In. | Vee, ° | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|---|
| 3/8 | 30 | 650 | 34 | 18 | 1/4 | 0.30 |
| 7/16 | 30 | 700 | 34 | 15 | 1/4 | 0.35 |
| 1/2 | 30 | 700 | 35 | 13 | 1/4 | 0.40 |
| 5/8 | 30 | 750 | 35 | 11 | 1/4 | 0.50 |
| 3/4 | 30 | 750 | 35 | 8.5 | 1/4 | 0.60 |

* Used as shown for flat keel, bottom shell, deck, bulkhead and tank top joints.

**Joint No. 6—Non-Positioned Unionmelt Fillet Welds***




| Normal Fillet Size, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|
| 1/8 | 350 | 27 | 34 | 1/8 | 0.06 |
| 3/16 | 350 | 28 | 30 | 1/8 | 0.09 |
| 1/4 | 450 | 28 | 25 | 1/8–5/32 | 0.14 |
| 5/16 | 500 | 28–30 | 22 | 5/32 | 0.20 |
| 3/8 | 550 | 30 | 18 | 5/32 | 0.31 |
| 1/2 | 750 | 33 | 12 | 3/16 | 0.53 |

* Used for joining bulkheads to tank tops, etc.

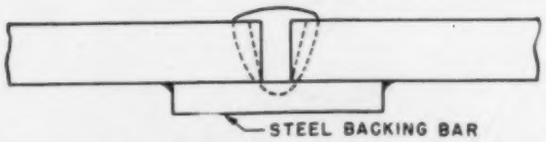
because of the unusually high welding speeds and the resulting rapid rates of initial cooling of relatively large volumes of molten metal in the weld. Contaminating materials such as water, oil, paint, heavy scale and rust are usually removed by wire brushing or rapid surface heating with a concentrated oxyacetylene flame. If the plates are carefully protected and the work of assembly and welding is properly organized, a light wire-brushing just before welding will be the only surface preparation needed.

Steel of questionable weldability is occasionally encountered in shipyards and has sometimes required special procedures. Care in assembling and cleaning, slower speeds, higher quality welding materials, or perhaps additional passes of welding, tend to improve the results regardless of the method of welding being used.

## Conclusion

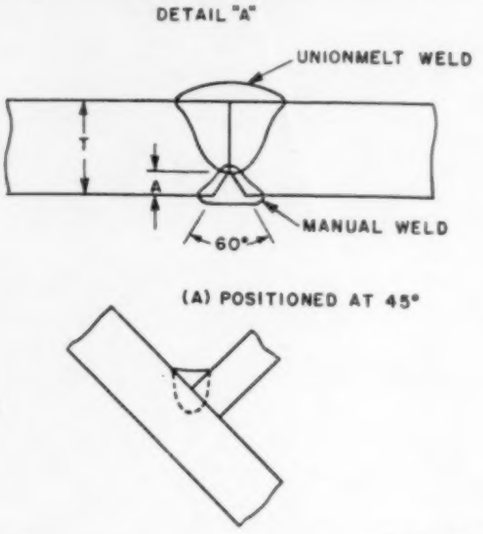
Manual metallic arc welding still continues as the principal welding method in ship construction. Skilled arc-welding operators go everywhere on a ship, weld in

**Joint No. 5—Integral Steel-Backed Unionmelt Butt Welds**




| Thickness, In. | Edge Preparation | Minimum Spacing, In. | Minimum Thickness Backing Bar, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Welding Rod Lb./Ft. |
|---|---|---|---|---|---|---|---|---|
| 1/4 | Square | 3/16 | 1/4 | 950 | 27 | 34 | 1/4 | 0.17 |
| 5/16 | Square | 3/16 | 5/16 | 1000 | 27 | 27 | 1/4 | 0.23 |
| 3/8 | Square | 3/16 | 3/8 | 1000 | 27 | 26 | 1/4 | 0.24 |
| 7/16 | 30° Vee | 1/4 | 3/8 | 1100 | 27 | 22 | 1/4 | 0.32 |
| 1/2 | 30° Vee | 3/16 | 3/8 | 1200 | 27 | 16 | 1/4 | 0.54 |
| 9/16 | 30° Vee | 3/16 | 1/2 | 1200 | 27 | 12 | 1/4 | 0.80 |
| 5/8 | 30° Vee | 3/16 | 1/2 | 1200 | 28 | 11 | 1/4 | 0.90 |
| 3/4 | 30° Vee | 3/16 | 1/2 | 1200 | 28 | 9 | 1/4 | 1.10 |

**Joint No. 7—Positioned Unionmelt Fillet Welds**




| Normal Fillet Size, In. | Amperes | Volts | Speed, In./Min. | Welding Rod Diam., In. | Lb./Ft. |
|---|---|---|---|---|---|
| 1/8 | 400 | 27 | 36 | 1/8 | 0.04 |
| 5/16 | 500 | 27 | 32 | 1/8 | 0.07 |
| 1/4 | 650 | 27 | 28 | 5/16 | 0.11 |
| 5/16 | 650 | 28 | 22 | 5/16 | 0.17 |
| 3/8 | 750 | 29 | 18 | 5/16 | 0.25 |
| 1/2 | 850 | 31 | 16 | 1/4 | 0.43 |
| 5/8 | 950 | 31 | 13 | 1/4 | 0.66 |
| 3/4 | 1080 | 31 | 11 | 1/4 | 0.95 |

NOTE: These conditions if used in applying a fillet to each side of the web plate will yield 100% penetrated tee joints with the work positioned at 45° where the thickness of the web plate is equal to or less than the size of the fillet leg.

every position and under most any conditions. Without doubt, they will continue to perform over 60% of all ship welding and will deposit an even higher percentage of the total weight of welding rod used.

Nevertheless, shipbuilders have shown keen interest in Unionmelt welding, though the process is relatively new. Its production rate is high; long training periods are not necessary for operators of the equipment; the investment cost is reasonable, and operating costs are attractive. From some shipyards working on Maritime Commission vessels come reports that the overall costs of completed Union melt welded seams are about half of those made by other welding methods.

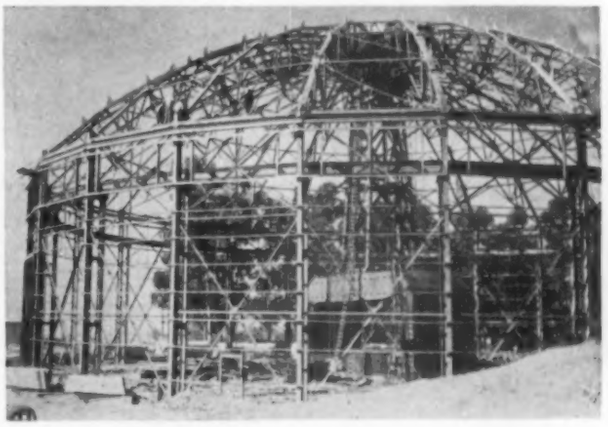
Looking ahead to the immediate future, it seems inevitable that manual and automatic processes of welding, manual and mechanized methods of flame cutting, and older shearing, punching, reaming, bolting, riveting and calking processes will all be used to the limit during the coming months, for the nation's shipyards are being called upon to produce four million tons of cargo shipping per year by 1943, and a two-ocean Navy by 1947. No method of construction will be overlooked in this emergency effort, providing it produces the maximum results with the equipment and man power which are available. But, undoubtedly, out of this situation calling for the utilization of all processes, will come valuable comparisons and technical production data which will guide us in choosing the most economical and efficient methods of building ships in years to come when world conditions again return to normal.

# Arc-Welded Cyclotron Takes Shape

By A. F. Davis*

CONSTRUCTION work on the $1,500,000 cyclotron of the University of California at Berkeley—the greatest atom smasher in scientific history—progresses despite foreign wars and domestic defense efforts.

The great device, which may release the huge energies of the atom and solve many problems for the farmer, consumer and manufacturer, is being made of 4900 tons of steel.



**The World's Largest Atom Smasher Takes Shape. Beneath the Steel Frame of Its Housing the Partially Completed Cyclotron of the University of California May Be Seen. The Cyclotron Itself Is Almost Entirely Arc Welded to Resist Atomic, Electrical and Atmospheric Stresses**

One of the big magnets—the world's greatest—is seen in the center of the housing in the picture. This magnet weighs 300 tons and is made of slabs of steel 58 feet in length, 6 feet 3 inches wide and 2 inches thick, each of which weighs 17 1/2 tons. These slabs were welded together to form the huge laminated magnet core seen in the center of the shed frame.

The scientists behind the construction of the venture specified arc-welded steel to resist the atomic bombardment, the great electrical and magnetic stresses and the strain of the world's largest vacuum.

* Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

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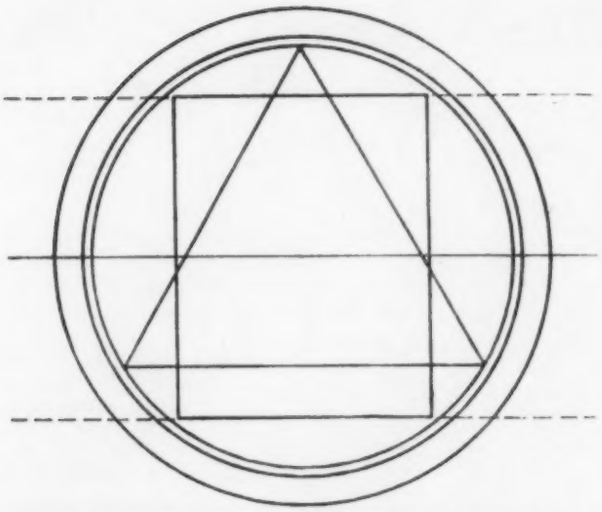


Fig. 1—Boom Jig Center Unit. Boom in Jig Completes a Rectangle, a Triangle, Triple Circles and Triple Parallel Lines, the Center Line Being Imaginary

# An Original Revolving Type Boom Jig Speeds Complicated Work

By Harry J. Hibbett*

THE Osgood Company of Marion, Ohio, builders of power excavating and material handling machinery, has found an ever-increasing demand for booms of welded construction. These boom requirements were for lengths ranging from 25 ft. up to 85 ft. for structural booms used in dragline and crane service, and for shovel booms built up of varying thicknesses of steel plates to produce booms ranging in lengths from 16 ft. to 35 ft.

In the production line, it is necessary to build these booms accurately, efficiently and, of course, straight. This problem was met by designing and building a special jig of the revolving type (Fig. 2). The jig was fabricated within its plant and has now been in operation for more than 18 months. In that period, a quantity of booms that can be designated in three figures have been built in this jig, all of them meeting in full the requirement for straight booms, accurately and efficiently constructed. Numerous small three-piece structural booms have been built. These have a removable center section secured by forty $^1/_2$-in. machined body bound bolts so that the center section can be removed, making a two-piece boom with a perfect joint and requiring no drifts or reamers to remove or to reinsert the removable section. The continued repetition of accurate performance definitely provides sufficient evidence that this revolving jig is a certified reality in the science of better boom building by the correctly controlled process of arc welding.

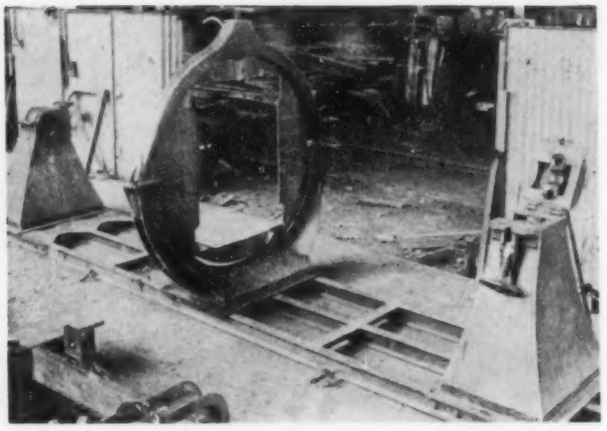


Fig. 2—The Basic Jig

The control consists of a fabricated center unit including a rectangle, a circle and a triangle, roller hinged enclosure in design (Fig. 1). The top roller is adjustable to permit revolving in any degree of the circle, retaining a perfectly neutral center.

The end bearings permit expansion and contraction of the trunnion attachments with $^1/_{64}$-in. freedom, holding a positive center of gravity axis not exceeding $^1/_{32}$ in. regardless of the length of boom constructed (Fig. 3).

Our readers will note we guide in a straight line, by first tack welding the pipe lacing. We then proceed to weld from center in either direction, revolving the boom to permit all down-hand welding in circular movements. Thus we reduce to a minimum the locking up of any internal stress or strain, all stress and strain being free to adjust themselves naturally.

No straightening being required of the finished boom, we retain a major portion of metal life, strength and value of material fabricated or assembled

This combined equipment has a substantially high safety factor provision in that rotating bearing caps and closures are positive locked by screw and wheel. The merit of this safety feature is incalculable.

* General Foreman of Structural, Forge and Welding Divisions of The Osgood Company, Marion, Ohio.

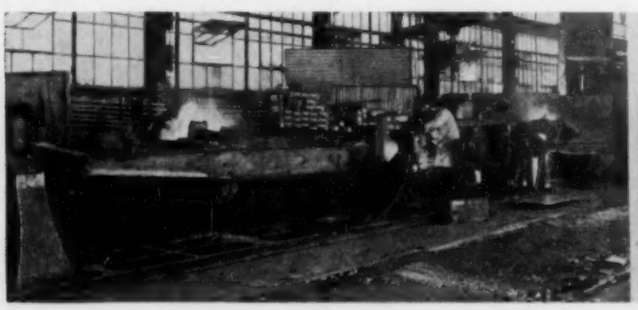


Fig. 3—Three Small Shovel Booms in Production

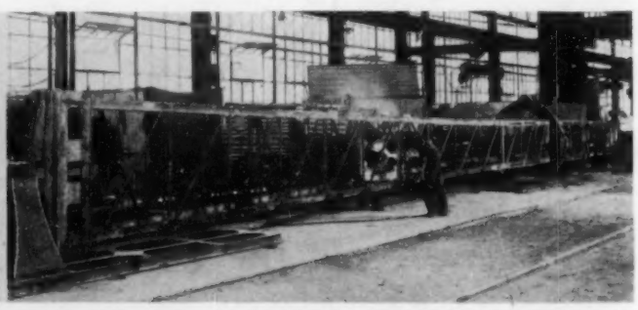


Fig. 4—An Eighty-Foot Dragline Boom in Production

# Continuity Through Welding

## A Discussion on Published Articles

By Martin P. Korn*

THE WELDING JOURNAL for September 1941 contains an article by G. G. Landis that is both stimulating and provocative. Its title is "Welding Makes Continuity in Steel Advantageous." In few words requiring a short reading time, vast savings are indicated.

Part of a building frame is illustrated. A uniform load is indicated. Designed for simple beam moments a 14-in. WF 43 lb. is required. "Figured the way reinforced concrete would be," to quote the author, and welding beam for continuity at both ends, a 14-in. WF 30 lb. suffices.

Savings in steel, 43%.

Savings accomplished by substituting 12 for 8 in the simple beam formula. That is all there is to it.

Continuity through welding turns sparks into sparklers.

In the same issue of THE WELDING JOURNAL is another interesting article by C. Harold Louree. Its title is "Fundamentals of Structural Welding Design." Many moss-covered designers of this day need those fundamentals. When they start reading they yearn for more than the fundamentals.

The article states, "Take advantage wherever possible of the natural adaptability of welding to continuous and rigid frame types of construction in which rigid joints are required. Remarkable savings in costs can often be realized with this type of welded construction."

Remarkable savings in costs! Continuous and rigid frame types of construction! The reader might or might not like the sound of that new-fangled rigid frame continuity and all that. Hardly any one, however, would fail to tune in on the remarkable savings. At this point in the article the reader's interest is provoked to a new high. Then when his hopes have soared to a pinnacle, the article suddenly flashes a distress signal with the cryptic message which I quote, "Unfortunately the application to building frames of methods of analyzing continuous structures is exceedingly laborious."

That settles that. Banish all thoughts at once for remarkable savings. One who writes must be diplomatic in his language. But to all of us readers it means simply that it is not worth dying for.

Both of the above articles proclaim with unanimity the vast savings possible from welding through continuity.

One achieves such savings by almost magic analysis—substituting 12 for 8.

The other shies from such savings because of labor pains in analysis.

In behalf of continuity, the facts will be mustered so as to insure its fair appraisal.

### Article—"Welding Makes Continuity in Steel Advantageous"

Figure 1 herewith is a reproduction of the illustration in the original article. Nothing is mentioned to indicate that it is an actual building design. We might then assume that it is merely an illustrative example. As such we know nothing whatsoever about the contiguous members to those shown. Neither do we know anything about their relative stiffness ratios. Such information is absolutely essential for safe and correct design for continuity.

Designers must never isolate and design individual members of a rigid frame by themselves. As proof of this I shall, like the author of the above article, turn to the concrete authorities. Section 801 of the Joint Committee Report on Concrete Specifications for 1940 says "The Committee takes the position that the design of a monolithic frame as an aggregation of isolated members is not tenable."

In this example nothing whatsoever mentions bending in the columns. Bending actually occurs in the columns.

Just as soon as you weld any beams for full continuity they become part of a rigid frame. The welded beams lose their independence immediately and their behavior

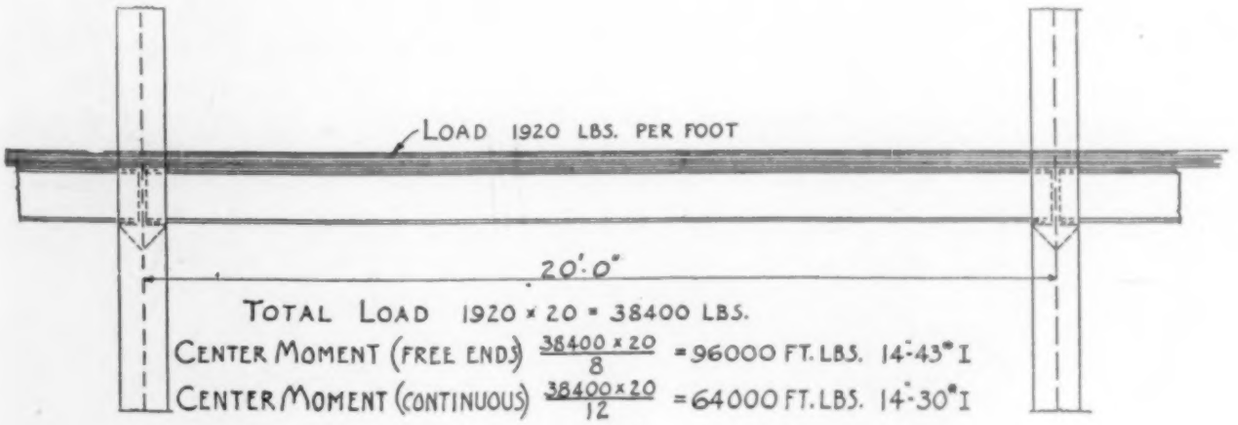

LOAD 1920 LBS. PER FOOT
20'-0"
TOTAL LOAD 1920 × 20 = 38400 LBS.
CENTER MOMENT (FREE ENDS) 38400 × 20 / 8 = 96000 FT. LBS. 14"-43" I
CENTER MOMENT (CONTINUOUS) 38400 × 20 / 12 = 64000 FT. LBS. 14"-30" I

Fig. 1

* Consulting Engineer, Buffalo, N. Y.

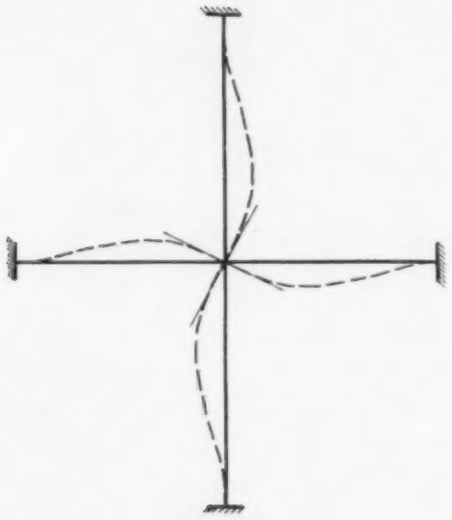


Fig. 2

becomes factors of their contiguous members and the loadings on those contiguous members.

Conversely the contiguous members change character and at once become dependent on those beams which you welded completely for continuity. In this example the contiguous members are the columns.

These columns have been utilized to restrain fully against rotation the welded beam ends. That means that the columns are now burdened with additional work over and besides their axial loadings. That additional work causes bending in the columns as in Fig. 2.

Whatever the columns were before the beams were welded for continuity at both ends, stronger columns and more tonnage will definitely be required. If now the design be properly completed, a 43% savings in steel will not exist. It may be true of the beams only. But for the entire building the gross savings will more likely be nearly half the amount stated.

Savings will definitely result from such continuity. That is what you want to know, also how much. Assuming conservatively that the saving in steel in the above frame is merely 20%, if it were a $100,000 job, your savings would be $20,000. That alone makes it all worth while.

The reader's problem is not one about how to save—that is a foregone conclusion with continuity through welding. Your problem is to save with safety. And to do that you must not forget your columns, even when as in some cases little bending occurs. For proof I refer you to the Joint Committee Report previously mentioned which says, "When the stiffness and the strength of the columns are utilized to reduce moments in beams, girders . . . the need for recognizing column moments is OBVIOUS."

In designs of some types of frames column moments may from a practical standpoint become inconsequential. Figure 4 is such an example in which continuous beams are lightly welded to the columns along their bottom flanges.

In Fig. 4 it is possible to weld the bottom beam flanges solidly to the columns and still develop column moments that are inconsequential from a practical standpoint—depending upon the stiffness ratios. No single generic statement or coefficient will cover all conditions. Every design must be analyzed by itself to determine the magnitude of the column moments.

We will now consider the coefficient of one-twelfth used in the illustration in this article.

That coefficient cannot be used for design of beams in Fig. 5 even though they have equal spans and are equally loaded.

It might safely be used in Fig. 6, but only for the center beam—only one out of three beams in this type of frame.

It can never be used for frames of such unequal spans as in Fig. 7, even though the beams be uniformly loaded. Many buildings have such unequal spans.

In the case of Fig. 8 negative moment occurs throughout the entire center spans. If this center beam, *BC*, were isolated for design by the one-twelfth coefficient as in illustration 1—and it could easily be done by an unwary reader—the design might prove calamitous.

Coefficients are the every-day tools of the thoroughly experienced structural designer. In his hands they work as effectively as a maze of wires to an experienced switchboard operator. They make for speedy and safe design on many types of structures. In the hands of any but the thoroughly experienced structural designers, they could easily prove as disastrous as loaded pistols to children.

The one-twelfth coefficient used in Example 1, Fig. 1, of the above article is a good tool giving good performance under certain conditions. But sufficient illustrations have been presented herewith to indicate its utter uselessness and danger in many cases. If, then, you would be safe, consider every coefficient you handle as loaded, and hang a red flag on it.

Too many handbook designers and others who want designs without designing would just reach out and grab at coefficients that are handed out as so many free samples

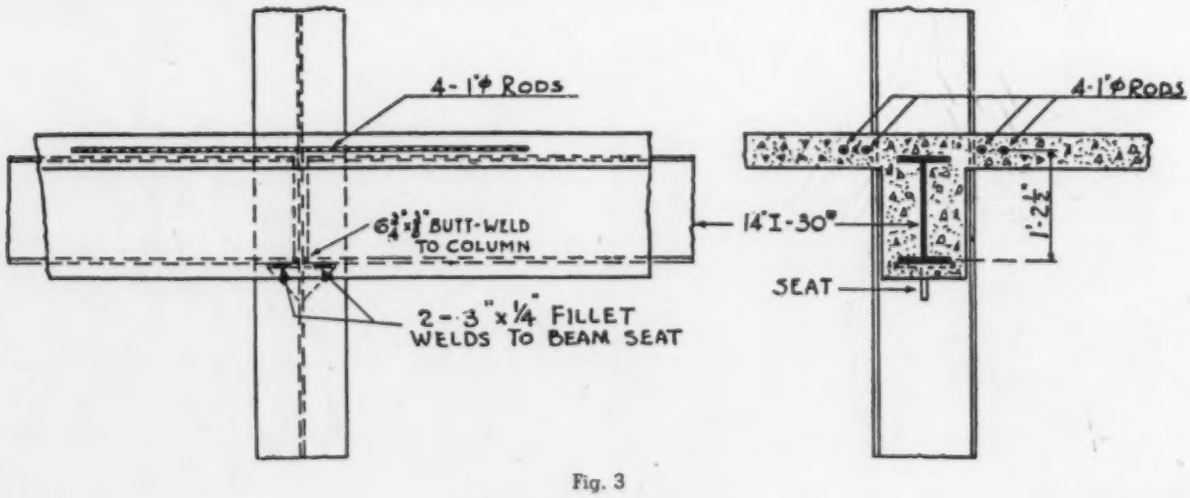



Fig. 3

for distribution. If some of those persons followed the example in Fig. 1 to design floor beams in types of structures illustrated in Figs. 5, 7 and 8 herewith, they would create a path of ruin for themselves and for the future of welded structures. Section 801 of the Joint Concrete Committee Report for 1940 says, "The design based on the usual moment coefficients often leads to improper design and quite generally to wide departure from uniformity of factor of safety in the various members of the structure." That committee, however, recognized the usefulness of coefficients if and when they are properly used.

The one-twelfth coefficient used in the above article to realize the advantages of full continuity is applicable only to an "Ideal" type of building in which all columns are equally spaced and the floor uniformly loaded. Even in these ideal types of frames, the end spans require different coefficients and the external columns special consideration. Ideal types of building frames do not occur in practice very frequently. They seldom occur in industrial structures. The selection of an ideal type to illustrate this article lends itself to easy presentation to readers. In that respect it should serve to stimulate interest in the advantages that welding affords through continuity.

This article referring to tests made at the University of Toronto also gives an example in which beam tonnage is reduced as much as 25 to 30% in a composite design of steel and concrete beams for continuity. Figure 3 herewith is a reproduction of that illustration in the article under discussion.

The floor beams have been butt welded to the columns only along their bottom flanges. At this point in construction end rotation of the beam ends occurs exactly as in simple beam design and loading. By placing four 1-in. diameter reinforcing bars at top of the concrete slab, full continuity is at once created in the floor beams.

The article states, "Whenever reinforced concrete slabs are used as flooring in steel frame buildings, a simple method of obtaining continuity for steel beams is shown in Fig. 3."

It appears simple. Analysis of the design, however, is not as simply executed as indicated. Too many other and dependent factors must be jointly considered.

In the first place the mere presence of reinforced concrete slabs in a steel beam tier building will not make them effective toward a composite design. The composite design must also provide concrete encasement of the steel beams besides the concrete floor slabs. The illustration, of course, clears up this point which the quoted statement does not cover.

Figure 3 will probably apply to an ideal frame and definitely only to limited parts of an ideal frame, not to the whole of it. It inherits all the limitations of Fig. 1 for a typical illustration, all of its possibilities for unsafe design. It, too, like Fig. 1 must not be designed as an isolated member. It must be designed as a component part of a rigid frame. Add to that the fact that the reinforcing bars make of the steel beam and concrete encasement a composite tee section and you have a hybrid rigid frame composed of hybrid members whose behavior for design analysis would challenge the knowledge even of structural experts.

As to the novitiate whom this inspiring article would convert to continuity through welding, it is questionable whether they could with safety mix up the right proportion of structural steel, concrete, reinforcing bars and welding. It is even more questionable what they would have when finished which could not be accomplished by an all-welded steel rigid frame with the customary concrete floor slabs or an all-concrete frame.

This reviewer many years ago designed a composite structure of steel beams encased in concrete in which the steel beams were first made continuous. In an article, "Design of Welded Rigid Frames," published in THE WELDING JOURNAL for January 1940, it was indicated how top reinforcing bars used similarly to the example covered by Fig. 3 would make for additional savings in welded rigid frames. Here, then, is proof that this reviewer is not prejudiced against composite types of designs. It is only, however, because of actual experience therewith that I see complications in a design in which the steel beams are first welded to permit full end rotation as in simple beam design, then encased in concrete, then made to exercise full restraint against end rotation by the use of reinforcing bars.

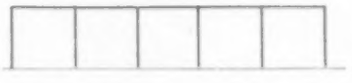
A little more welding and you get full restraint of beam ends for continuity exactly as in Fig. 1. You now have a safe design, a sure structure whose behavior you can understand. Then if you want still more economy and desire to put the concrete encasement to work also the slab, the effect resulting by adding reinforcing bars for negative moment as in Fig. 3 will be tantamount to merging your continuous steel floor beams with continuous concrete floor beams. This should lend itself to more simple analysis, and you are more likely to have a sound design.

The discussion of this article aims solely to clarify some points which, depending upon their interpretation by readers, can very easily lead to incorrect application. What is simple to Mr. Landis, author of that article, may in the eyes of others read as Greek. Anyone acquainted with him will at once recognize his outstanding ability and the value of his articles to the progress of welding.

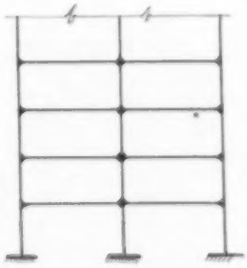
### Article—"Fundamentals of Structural Welding Design"

This article proclaims to the full the remarkable savings possible from continuity through welding. Unlike the preceding article, it registers abject despair because of the labor required for the desired results. Its exact words, "exceedingly laborious," signify hopelessness to its readers.

This public declaration comes at a time when by acts

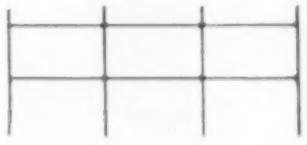


ONE STORY BUILDING
CONTINUOUS ROOF BEAMS
EQUAL OR UNEQUAL SPANS

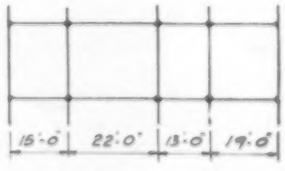


MULTIPLE STORY BLDG.
2 BAYS WIDE
EQUAL SPANS-UNIFORM FLOOR LOADING

Fig. 5

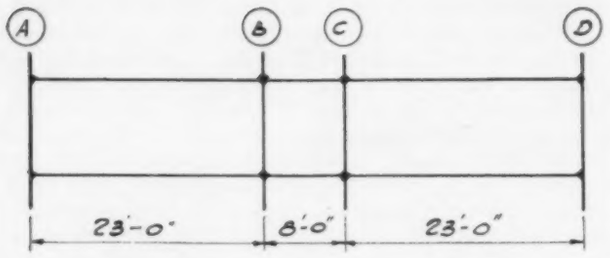


EQUAL SPANS
UNIFORM FLOOR LOADING
MULTIPLE STORY BLDG.




UNEQUAL SPANS
UNIFORM FLOOR LOADING
MULTIPLE STORY BLDG.

Fig. 7




UNIFORM FLOOR LOADING
MULTIPLE STORY BLDG.
Fig. 8

and words, universal acclaim is being accorded continuity.

In 1935 the Portland Cement Association in its pamphlet, "Continuity in Concrete Building Frames," stated, "The aim is to present analytical procedures that are practical, i.e., quick, easy, convenient and yet sufficiently accurate for office design practice." That was done with great success.

Today every reinforced concrete building design is based upon continuity. Look around everywhere and see the endless number of new buildings going up. Apparently hordes of engineers throughout the country are unmindful that it is exceedingly laborious. Even if they are, they are nevertheless setting up a new record for speed in executing such designs.

Within the past twelve years many new and different methods of analysis for continuity have been published, each in its own way making for great or greater simplification in design, one such simple procedure being Hardy Cross Moment Distribution.

The new and revised edition of the Building Code about to be published by the AMERICAN WELDING SOCIETY will unconditionally permit welded rigid frame design. (No despair there.)

The new and revised edition of the *Welding Handbook* now in course of completion, commending continuity through welding, will also commend its every-day use because of the simplification brought about in the mathematics in rigid frame solutions.

Last but not least, during every working day of the past eighteen months, designs have been made of continuous and rigid frame structures. All over the country in private practice, in municipal, state and federal offices, continuous rigid frame structures are being designed of steel or concrete at an unprecedented rate of speed, setting up a record unparalleled in the history of structural design.

Thus speaks the country. Thus speak all records for continuity.

Soon—very soon the AMERICAN WELDING SOCIETY Building Code and the revised edition of the *Welding Handbook* will speak to the country officially for continuity through welding. They will decree its use unconditionally. But welding through continuity is already here. It is here to stay for all time. This reviewer, speaking for himself as a member of both of the above committees, as one of the original sponsors for their adoption of continuity, urges upon all readers the study of welding in these books, the study of continuity through any good textbooks. Then make your own decisions based upon factual data.

In behalf of "Continuity Through Welding," our new child about to be christened, let us not acclaim for it unattained wonders, let its living works speak. Let its growing pains and faults be criticized only on facts and knowledge. If we write, let us write from knowledge and facts—let us write of it gently.

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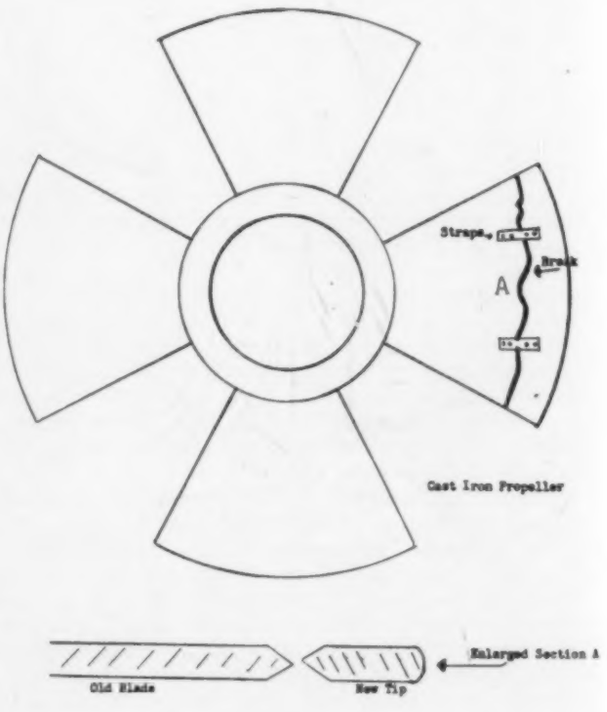
# Propeller Repair

By Robert Wagner*

MOST propellers for tow boats, lighters and other small commercial craft are made of cast iron, because if such a propeller strikes a log or floating debris, it will break. This relatively easy breaking prevents serious damage to the boat's engine. The breaking off of a large piece of blade, however, frequently requires laying up the ship for repair in dry dock.

Very frequently, there are no spare propellers available. A highly successful method of repairing the blade is by bronze welding. After the boat is in dry dock, the propeller is turned so that the broken blade is horizontal (see sketch). Two methods are common. The first method is to cast a manganese bronze tip and weld it to the damaged blade. The second method, considered better by most maintenance men, is to bronze weld a scrap cast-iron propeller blade to the damaged one. Many foundries, making a specialty of cast-iron propellers, often have discarded ones lying around, or there may be several where the dry dock is located. A propeller should be selected as nearly as possible similar to the original one. The blade is chipped to the shape of other blades on the damaged boat—the necessary section cut off by drilling holes or sawing. Then the




* Hobart Brothers Co., Troy, Ohio.

repair part and the damaged blade edge are Ve'ed on both sides (see enlarged section A in sketch).

Next holes were drilled in the damaged and new blade so that steel straps can be placed for metal joining. The blades are fitted together with the points of the V touching. The V's are cleaned to remove all dirt and grease. Then the V's are heated slowly with an oxy-acetylene torch to about 450 degrees. Finally the V's are filled in on both sides by bronze welding, using a bronze electrode and an electric arc welder. Excess metal is ground off. After blade has been joined, straps and bolts are removed.

An excellent example of this repair method is the repair of cast-iron propeller of the tow boat *Boulker* at the Sullivan Dry Dock Co., Brooklyn, N. Y., in the fall of 1940. The entire procedure took less than 24 hours, and saved the owners several hundred dollars, plus valuable time. The *Boulker* made the trip to the Panama Canal at exceptionally fast speed, the bronze-welded cast-iron propeller being as satisfactory as the original propeller.

This arc-welding application was sent to the Hobart Arc Welding News Contest by Charles H. Hughes, prominent materials engineer, of New Dorp, Staten Island, N. Y.

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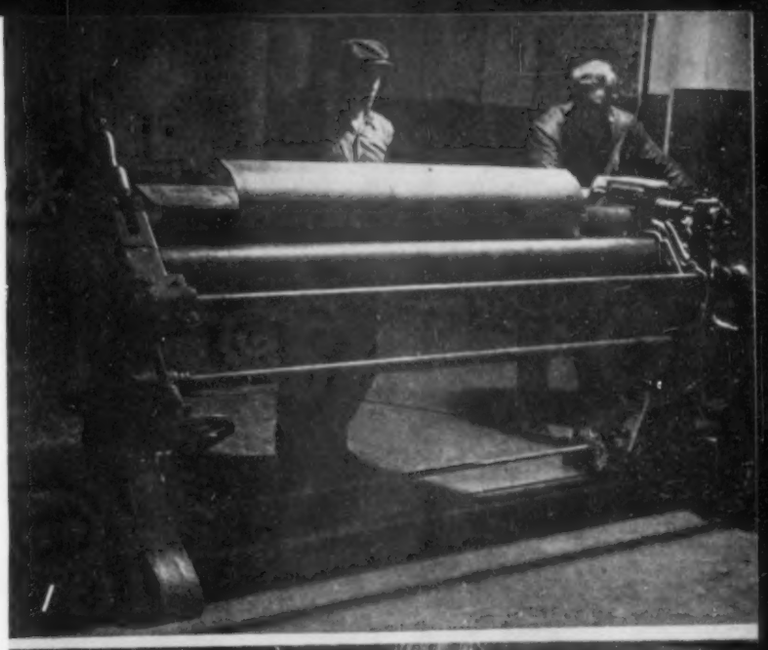
# Porcelain Enamel Hot Water Tanks

THIS series of photographs shows the step-by-step manufacture of porcelain enamel hot water tanks by Porcelain Steels, Inc., Cleveland, Ohio. ARMCO Enameling Iron, made by The American Rolling Mill Company, Middletown, Ohio, is used exclusively. (All photographs by courtesy of The American Rolling Mill Company.)

Figure 1 shows the first step in the manufacture of a porcelain enamel hot water tank which is a simple rolling operation. The rollers form the sheared sheets into cylindrical shape ready for welding.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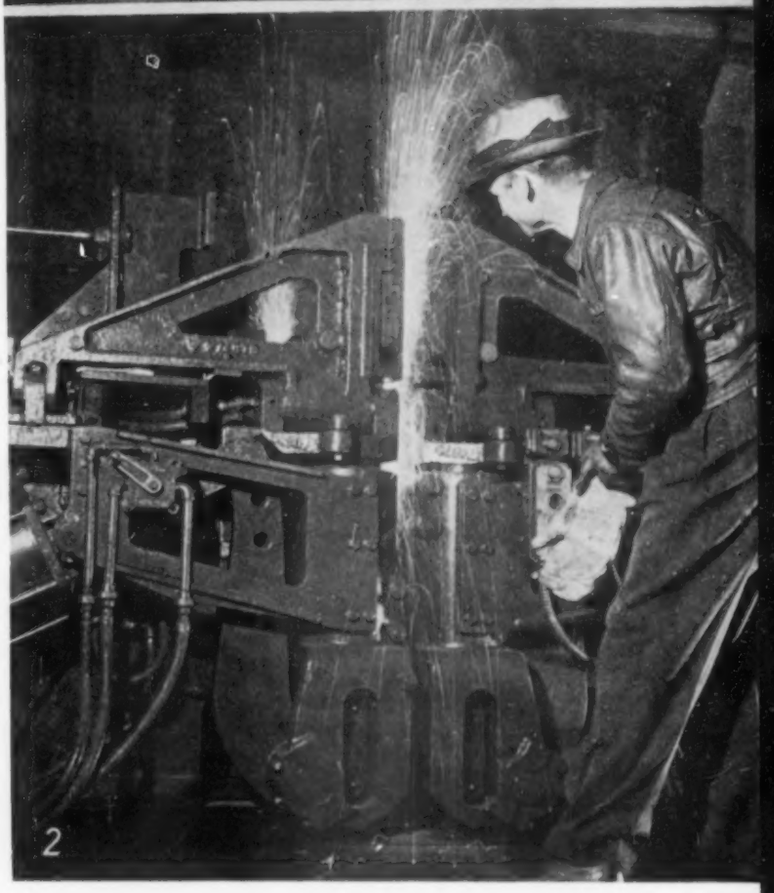

2

Figure 2—The edges of the rolled sheets are welded together in this 18-ton flash welder. In nine seconds this machine completes a weld 60 in. long. Power required for this weld is said to be sufficient to light 12,000 50-watt electric light bulbs. The combined electrical capacity of the machines in the plant is estimated about 3000 kva., or power sufficient to supply the electrical needs of a city of 10,000.

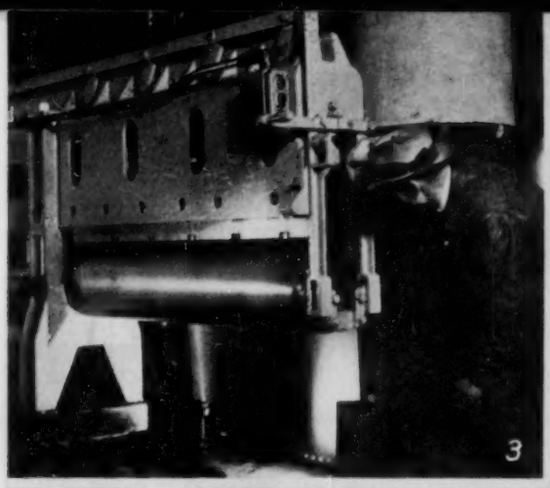
Figure 3—Before a cylinder progresses further it "goes under the knife." This scarfer is equipped with blades which carve away excess metal from both inside and outside the longitudinal weld in one operation.

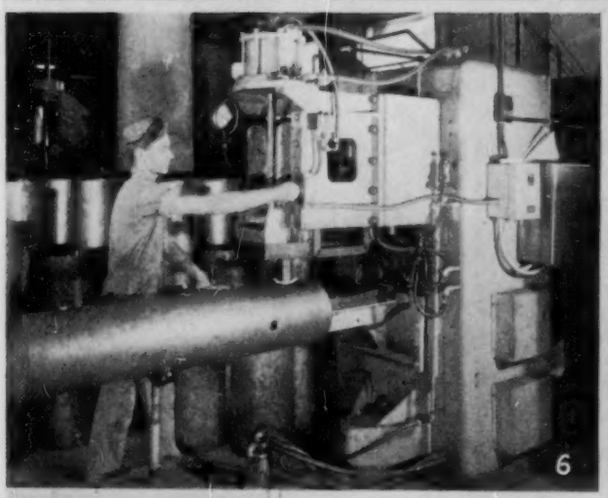
Figure 4—After the longitudinal weld has been scarfed both inside and outside, it is ground smooth. Only grinding can remove weld splatter which is unaffected by pickling. Should inspection reveal rough spots a second grinding operation is done. The cylinder is now given a uniform diameter by an expansion operation. One obstacle to the production of a good tank cylinder is the presence of a flat area next to the longitudinal weld. The flattened surface comes from the use of a three-roll bending machine. This machine fails to curve the first few inches of the sheet as it enters and leaves the rolls. The out-of-round condition makes it difficult to weld the heads to the cylinders. It also produces an area more likely to flex under pressure after the tank is in use. Reshaping the tank cylinder therefore is necessary.

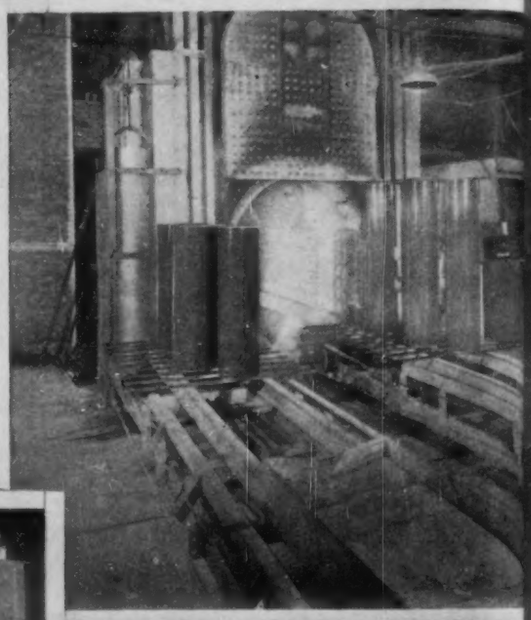
Figure 5—This machine punches holes in the cylinder shell, the first operation in making flanges on which the hand-made spuds may be welded. After the holes have been reamed to the proper size the small flange is created by extruding the shell metal.

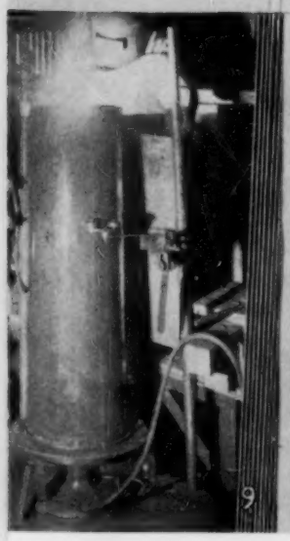
Figure 6—The spuds are welded to the tank shell with this flash resistance projection welder. The inside of the cylinder is smooth because the flanges are turned outward and the longitudinal weld has been scarfed and ground. Rough spots that might cause enamel defects are removed with files and abrasive cloth. The tank cylinder is now ready for the enameling plant.

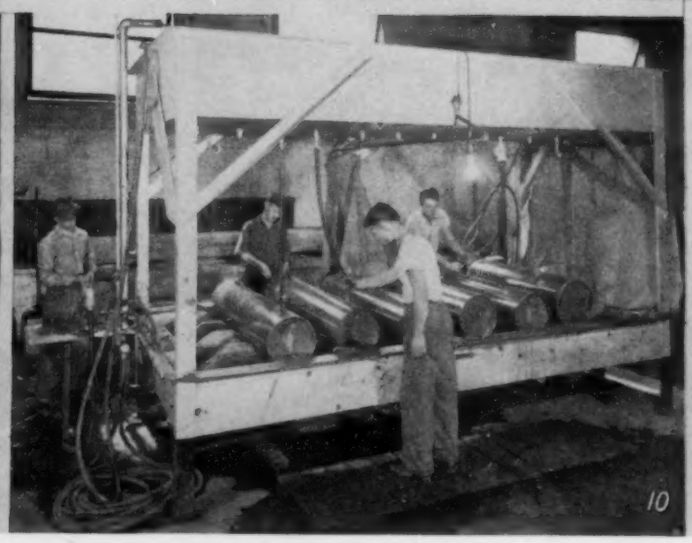
At the enameling plant the tank cylinder is immersed in

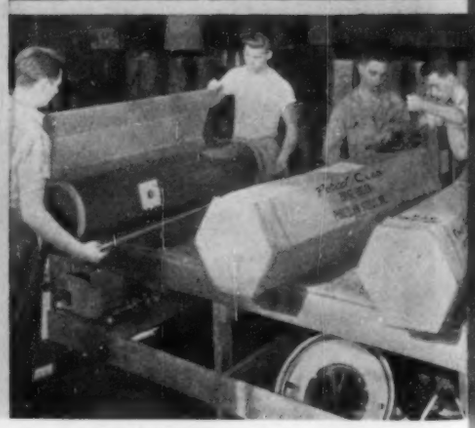








acid and boiling cleaner to remove grease, dirt, rust and scale. Thorough pickling provides a uniformly clean surface that is essential to the development of a good bond between the ground coat enamel and the base metal.

Figure 7—An ingenious though simple device is used to hold the tank while it is being dipped in the ground coat of enamel. After dipping the cylinder is placed in a drier, seen in the background. Narrow edges around both ends are brushed to provide an area of bare metal for welding on the heads. Now the cylinder is ready for firing.

Figure 8—The porcelain enamel ground coat is fused to the ARMCO Enameling Iron at 1650° F. in a box-type furnace. After the ground coat is fired the cylinder again is inspected for possible imperfections.

The finish coat of enamel is then sprayed on. Edges again are brushed to remove enamel and provide an area for welding after assembling.

Figure 9—A strip of glass cloth is placed between the tank shell and the heads as the heads are inserted in the shell. They are then joined by welding around the rim. The heat of the welding operation fuses the glass cloth, according to the manufacturer, making a water-tight joint inside the tank.

Figure 10—Tanks are tested by water under pressure. On the testing rack the tank's welded ends are examined with special care.

Figure 11—Tough composition rubber "bumpers" are placed on the ends of the tank in the packing and shipping department.

# Welding in the Aircraft Industry*

By Frank M. Smith†

JUST 64 years ago, at the Franklin Institute here in Philadelphia, the process of electric welding was discovered by Prof. Elihu Thompson of Lynn, Mass., while giving a lecture on electronics.

Not until 1886, however, did Professor Thompson actually perfect the process and build a machine to demonstrate the art. Perhaps no other one invention has been of so great a value to industry as this process of welding metals by electricity, and the possibilities of its adaptation for the future are infinite.

Credit for stopping the Prussians in their attempt to conquer the world in 1914–18 has been attributed to thousands of causes, but welding contributed in no small way to the final result, as without the aid of cutting and welding torches before which steel bulkheads and "I" beams melted away and wrecked main engines were welded together again as good as new, it would have been an utter impossibility to have altered the interned German liners and merchant ships for carrying the badly needed A. E. F. to France in time to stop the great rush on Paris.

It is said that out of every great disaster comes some good, and this is undoubtedly true of World War No. 1 so far as welding goes, for the urgency for rapid construction forced the abandonment of the older and slower methods of construction in favor of welding to an extent that the art progressed more in the 4-year war period than in the previous 28 years of its existence, until today there is hardly an industry utilizing metals in manufacture which does not use the process in some form, and its application will undoubtedly have a vast influence in the present World War, especially since its wholesale adaptation to the aircraft and ship-building industries.

Welding played a very small part in the aircraft industry during the last war, as practically all airplanes were then built of wood and fabric, but during the latter part of the war, shortage of spruce forced the Germans to substitute, and welded metal parts began to appear in their planes. One crashed fighter which the writer had an opportunity of inspecting, had utilized a welded terne plate gas tank as the pilot seat, and the whole cockpit was enclosed in $^{3}/_{16}$-in. welded steel armor.

Considerable experimental work in the application of welding was carried out at the Naval Aircraft factory in 1919–20 on duraluminum, but without much success. With the advent of the tubular steel fuselage in the early 20's, however, welding made its advent on a large scale in the aircraft industry. Acetylene welding, however, was first used for this purpose as practically all arc welders at that time were made for heavy welding, and the thin steel tubing used in aircraft could not be successfully welded with such equipment.

The first real set-up for production welding in aircraft was at the Moth Aircraft Plant in Lowell, Mass., where an acetylene generating plant was set up and gas lines run to all the welding benches and to fuselage jigs. This system was found vastly superior to the old portable bottle arrangement, not only from a standpoint of cleaner and hotter gas, but the provision of gas to every welding bench or jig eliminated the portable units and loss of time in handling, and provided a far more streamlined assembly line. Curtiss Wright, Great Lakes and others, later installed similar systems.

In the meantime, however, great strides had been made in the design of arc-welding equipment which could handle the thin steel gages, and men were being trained in its use. Arc welding was found to be not only much faster than acetylene, but allowed for the welding together of pieces of greater dissimilarity in gage, and also had less annealing effect on the material welded and confined such annealing to a closer proximity to the weld.

The vulnerable points in acetylene welded tubes were found to occur at a point $^{3}/_{4}$ in. from the weld, and in all crashes, failures occurred at these points. Naturally, the less the annealing and the closer this point was brought to the welded joint or junction of tubes, the stronger was the member.

In the meantime, the spot welding of steel had been perfected to a point where it had displaced riveting and bolting in practically all other industries, and had made especially great strides in auto production.

The necessity for riveting left the aircraft industry on a hand-made basis, as mass production was impossible with the necessity of drilling for and driving from 400,000 to 900,000 rivets, as used in the Lockheed and Clipper ships.

The first successful spot welding of aluminum alloy

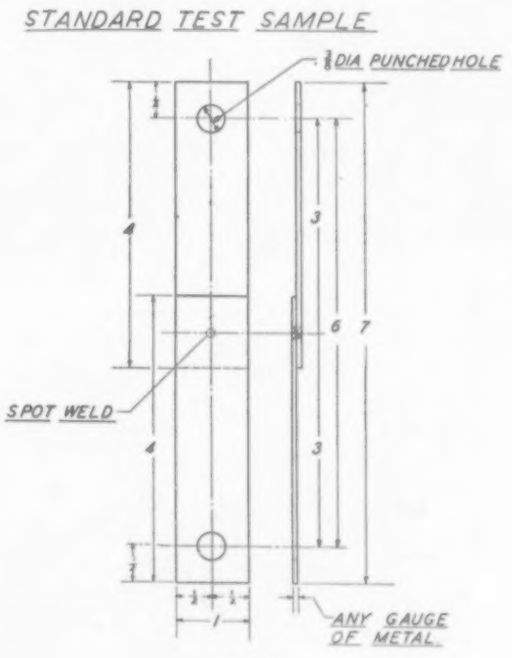



Fig. 1

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† General Manager, Stout Skycraft Corporation, Dearborn, Mich.

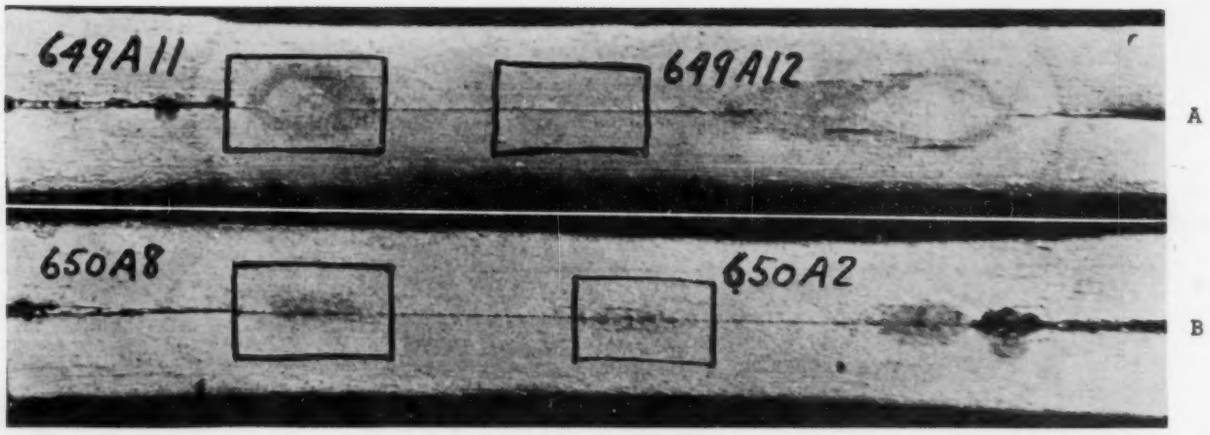



Fig. 2—Mag. 50X

The portions marked off in ink indicate areas shown at higher magnification in later pictures. On each side of the weld proper where the sheets have not been joined some staining has taken place as a result of the etching reagent seeping out of the junction between the two sheets while it was being photographed.

in aircraft took place in Europe on a magnetically stored energy machine, and the Germans are now making widespread use of it in their military planes. Our Civil Aeronautics Authority is the most conservative in the world, and although several U. S. welders are generally considered at least equal to the European process, spot welding of aluminum alloy has not yet received blanket approval for primary structures in aircraft, but is allowed in some cases on primary structures and on most all secondary structures.

However, with the advent of stainless and other high-tensile steels into the aircraft field, spot welding is really coming into its own and promises to enable the placing of the aircraft industry on a production basis commensurate with that of the automobile.

The rigid specifications and multiple restrictions issued by the C. A. A. for controlling the manufacture of aircraft, so necessary in an industry where a life may depend on a defective rivet or spot weld, precludes the use at this time of the multiple point jig set-ups now used throughout the automotive field, but as production increases, undoubtedly the welding and aircraft engineers will collaborate in the design of equipment and jigs which will allow for multiple point welding.

The many advantages of spot welding over riveting and metal screw fastening in the aircraft industry have already been clearly demonstrated in practice, and the principals of them are as follows:

1. Greater strength, 3 spot welds having the equivalent strength of 4 to 5 rivets.
2. Less man-hours are required due to the lack of necessity of drilling, reaming and aligning holes, and applying at least 25% more rivets than required welds.
3. In addition to specified spacing, rivets also require

Fig. 3—Mag. 200X

Cross section of the edge of the spot weld in Fig. 2A. The pitting that can be seen to have taken place is the result of the effect of the etching reagent on cold rolled steel. It is not indicative of defects.

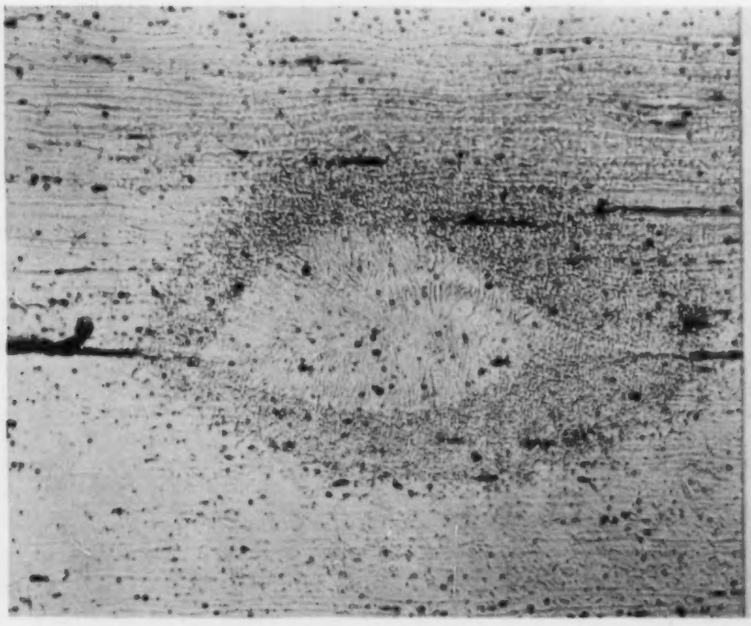


Fig. 4—Mag. 200X

Cross section of center of spot weld of Fig. 2. It can be seen that there is very little evidence of the two sheets having been welded.

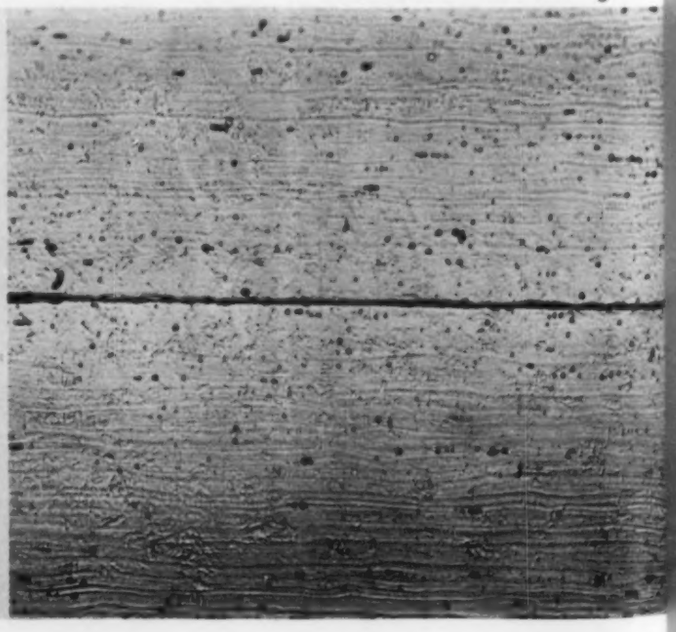


Fig. 5A—Mag. 50X

Spot weld sample No. 88 made on material 0.010 inch. Tensile Strength 235,000 psi. The machine setting was as follows:

| MFD | Volt | Primary turns | Tip pressure | Tip diameter | Pull tes |
|---|---|---|---|---|---|
| 53 | 1700 | 172 | 425 lb. | 1/8 | 460 |

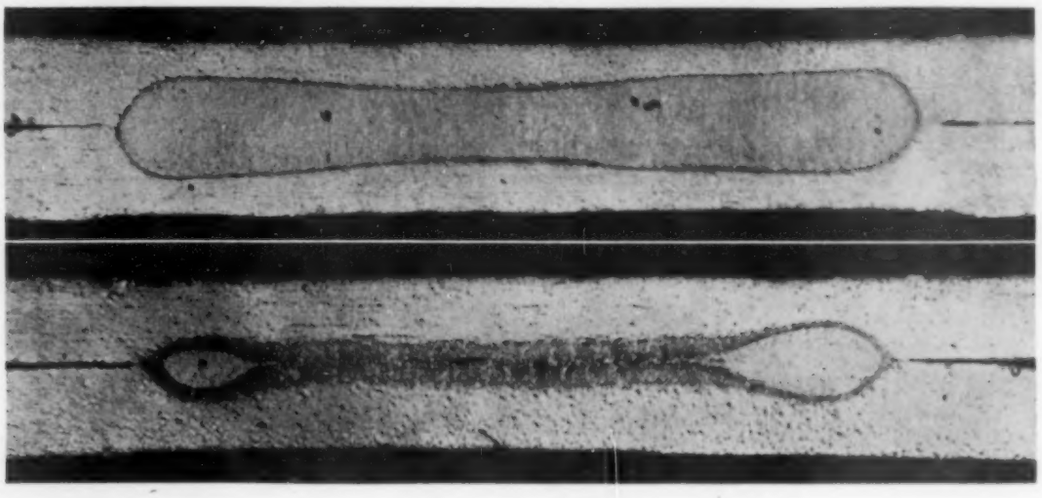



Fig. 5B—Mag. 50X

Spot weld sample No. 87 made on material 0.010 inch. Tensile Strength 235,000 psi. The machine setting was as follows:

| MFD | Volt | Primary turns | Tip pressure | Tip diameter | Pull test |
|---|---|---|---|---|---|
| 53 | 1600 | 172 | 425 lb. | 1/2 | 480 |

accurate landing edges which are not necessary with welds, and many more can be placed in a small area, providing a much more rigid structure with less material.

4. By the use of internal electrodes, welds may be placed in a structure where it is impossible to place a satisfactory rivet.
5. A considerable weight saving is possible with welds as on a plane carrying 400,000 or more rivets, the weight of heads and points is considerable.

Fig. 6A—Mag. 50X

Structure of the weld and the adjacent base metal on material 0.015 inch thick. Approximate machine settings and other information on the test are as follows:

| Thickness | Tip Radius | Mfd | Volts | Tip Press | Weld Strength | Army Air Corps Min. |
|---|---|---|---|---|---|---|
| 0.015 in. | 2 in. | 53 | 1850 | 600 | 575 lbs. | 460 lbs. per spot |

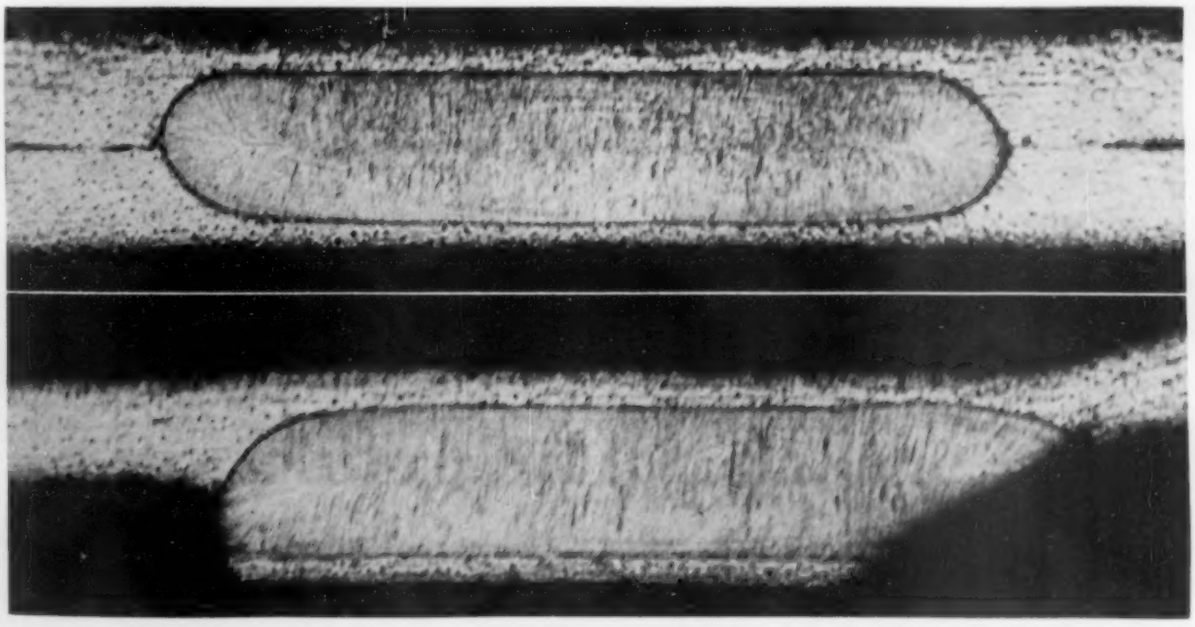


Fig. 6B—Mag. 50X

Structure of one-half of the pulled weld test and the adjacent base metal on material 0.015 inch thick.

**Fig. 7A—Mag. 50X**

Structure of the weld and adjacent base metal on material 0.020 inch thick.

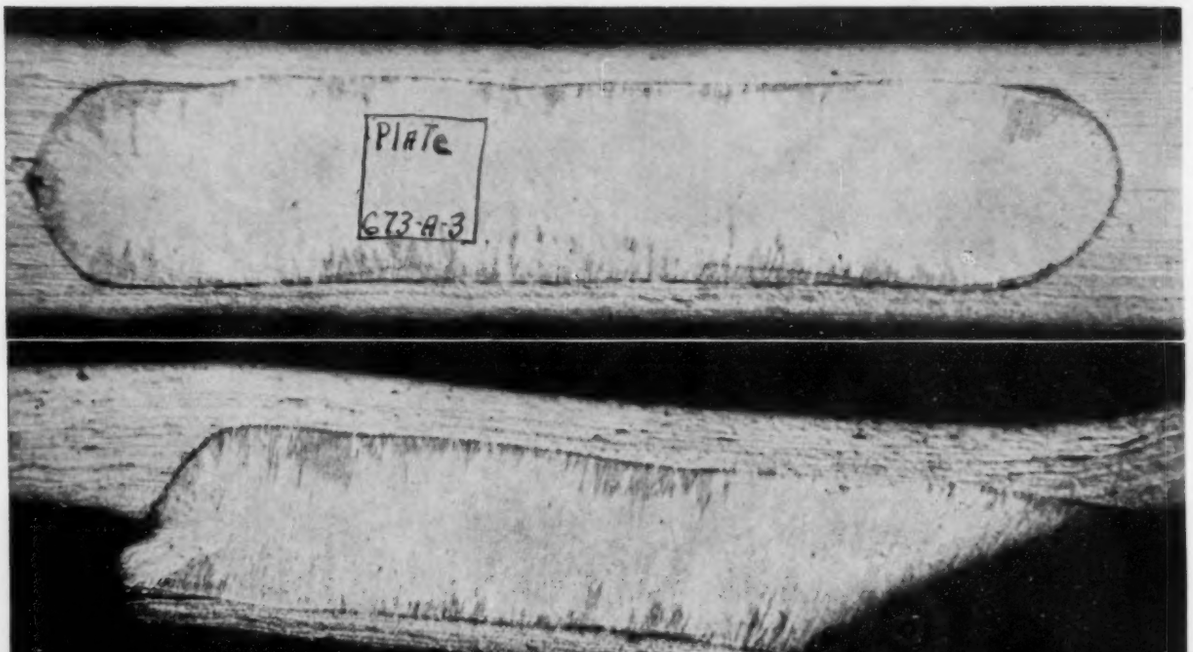



**Fig. 7B—Mag. 50X**

Structure of one-half of the pulled weld test and the adjacent base metal on material 0.020 inch thick.

Every ounce of weight saved means extra speed and useful load.

6. Recent tests carried out by the N. A. C. A. show that the parasitic resistance of rivet heads is a far greater factor as regards speed than was ever imagined, amounting to as high as 25 m.p.h. in the faster planes.
7. Fastening members in confined spaces is sometimes extremely difficult with rivets and elaborate dolly bars or other set-ups must be devised to accomplish it, and after rivets are driven in such places, it is difficult (if not impossible) to inspect them to determine their efficiency.

The average cost of an installed rivet is 0.05. However, in an attempt to eliminate speed-stealing rivet heads on the outer structure, flush rivets are now used, necessitating so-called "dimpling" of the skin which is too light in weight to be countersunk. The member to which the skin is riveted must also be "dimpled," and one can readily see the necessity of extremely accurate jigging in order to accomplish this, and the price per rivet, therefore, has increased to 0.10, which makes the staggering figure of around $40,000 for rivets *alone*, for a plane having a total of 400,000 rivets.

In an attempt to get away from the rivet problem and at the same time utilize a material which, through lack of corrosion will give longer life and safety, many companies have been experimenting with stainless steel with more or less success. Having a resistance of 8 times that of carbon steel and 14 times that of dural, it lends itself readily to spot welding.

One manufacturer is building a small plane entirely of stainless steel spot welded throughout, which is prob-

**Fig. 8—Mag. 20X**

Spot weld on material 0.040 inch. Tensile Strength 165,000 psi. Pull test 2400

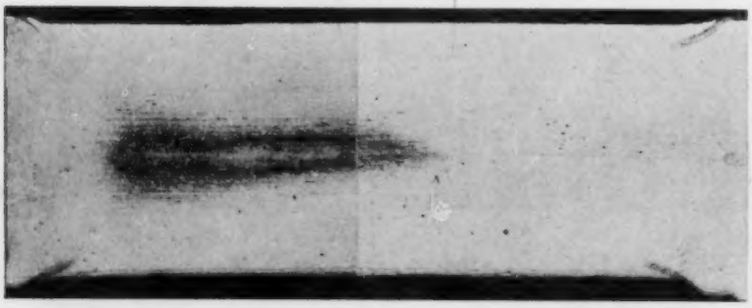
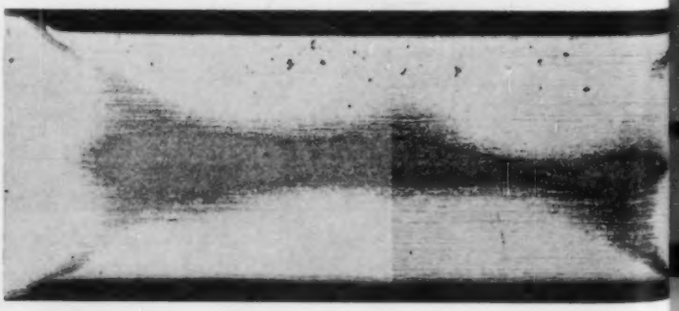


**Fig. 9—Mag. 20X**

Spot weld sample on material 0.040 inch. Tensile Strength 165,000 psi. Pull test 2800



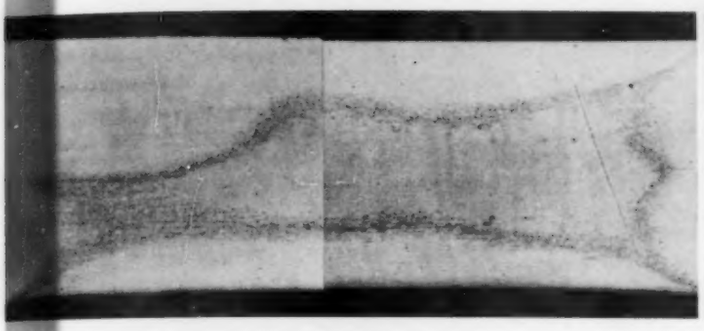


**Fig. 10—Mag. 20X**

Spot weld on material 0.040 inch. Tensile Strength 197,800 psi. Pull test 2420

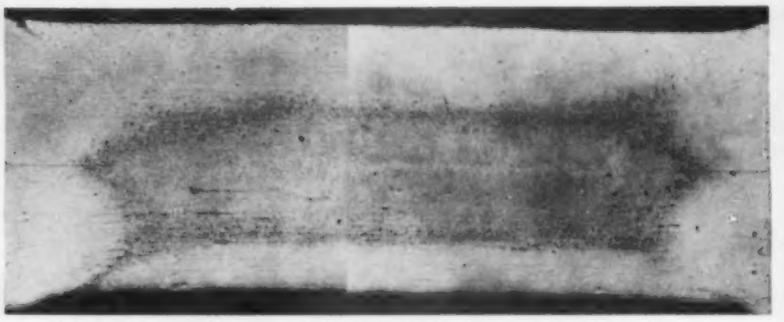


**Fig. 11—Mag. 20X**

Spot weld on material 0.040 inch. Tensile Strength 197,800 psi. Pull test 2720

ably the outstanding example at this time of the use of spot welding in aircraft work.

A very thorough investigation regarding stainless steel in 1939 indicated that there was very little data available regarding the fabricating of full hard material in the austenitic type, and practically no authentic data regarding the spot welding of this material, and what little there was, proved extremely unreliable apparently due to the fact that most calculations had been based on results obtained from test samples and that such a comparatively small amount of stainless sheet in the hard temper and thin gages had been used, that no opportunity had been allowed for compiling extensive data.

Exhaustive tests on many samples rolled from ingots of varying analysis proved that very slight changes in the elements, or their proportion to one another, produced a material which, while showing practically identical physical properties in annealed and low tensile states, was vastly different in physical characteristics after 30 to 45% cold reduction. A chemical analysis was finally arrived at which allowed for material having as high as 210,000 lb. tensile strength with an 18% elongation. Naturally, such material lent itself readily to rolling or forming of almost any shape desired, and thereby greatly simplified the spot-welding problem, as the design could be made to meet the limitations of the spot-welding apparatus instead of the less flexible spot-welding apparatus having to meet design requirements.

A thorough investigation of the different spot-welding methods was next made, and thousands of samples made on all types of machines including several of the different makes of stored energy welding machines. While good welding results were obtained on all of these different machines, the more consistent work was obtained on the A.C. resistance welders. As these tests were made during the winter of 1940–41, however, when stored energy welding was a new process, it is possible that recent developments may prove that results obtained were by no means conclusive, but it would appear that the stored energy method has a much greater field in the welding of aluminum and aluminum alloy materials where minimum time and maximum current are required.

The set-up for welding as used on the small plane mentioned, is somewhat out of the ordinary and is designed to give a maximum of use from the equipment.

A 50-kva. A.C. resistance welder equipped with synchronous timing and heat control panel is used, the primary transformer has 8 tap settings and a booster is installed in the line in such a way that by throwing a switch and opening or closing a valve, pedestal points, or attached air gun, or hydraulic gun can be used.

It has been determined that while stainless steel welds readily, it is very sensitive, that is, different settings both in heat and time are necessary for slight changes in

**Fig. 12—Mag. 20X**

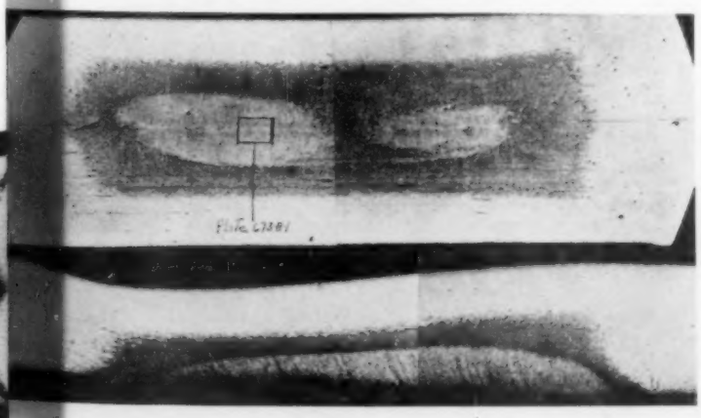
The upper photograph shows the structure of the weld and the adjacent base metal on material 0.040 inch thick. The lower photograph shows one-half of the pulled weld test on the same material.

Weld Strength 2100 lb.

**Fig. 13—Mag. 20X**

The upper photograph shows the structure of the weld and adjacent base metal on material 0.034 inch thick. The lower photograph shows one-half of the pulled weld test on the same material.

Weld Strength 1970 lb.



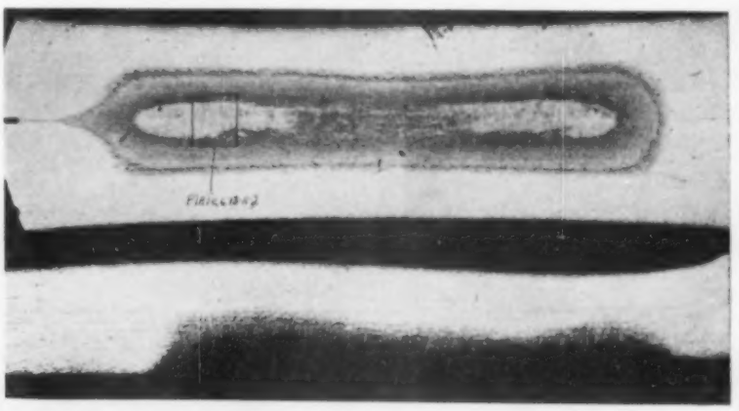


**Table 1—Machine Settings for Spot Welding High-Tensile Stainless Steel**

| Item No. | Stock Assembly | Approx. Weld Diameters | Electrode Pressure at Tips | Synchronous Timed Resistance Welder: Gage Pressure, Lb./Sq. In. | Time Cycles | Auto Transformer | Heat | Squeeze | Hold | Strength Req., Lb. | Weld Strength, 1-In. Test Sample | Remarks on Welds |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 0.010<br>0.020 | 1/8 | 325 | 27 | 1 | 1 | 95 | 10 | 10 | 275 | 620 | Good |
| 11 | 0.005<br>0.010 | 1/8 | 380 | 30 | 1 | 1 | 90 | | | 88 | 240 | Good |
| 12 | 0.010<br>0.031 | 1/8 | 391 | 32 | 2 | 1 | 95 | 10 | 10 | 275 | 620 | Good |
| 13 | 0.020<br>0.031 | 1/8 | 450 | 35 | 2 | 1 | 95 | 10 | 10 | 650 | 880 | Good |
| | 0.040<br>0.031<br>Bar | 1/8 | 450 | 35 | 3 | 3 | 75 | 10 | 10 | 1220 | 1280 | Good |
| 14 | 0.040<br>0.031 | | | | | | | | | | | |
| 15 | 0.040<br>0.015 | 1/8 | 450 | 35 | 1 | 1 | 100 | 10 | 10 | 460 | 800 | Good |
| 16 | 0.040<br>0.020 | 1/8 | 450 | 35 | 2 | 1 | 100 | 10 | 10 | 650 | 1200 | Very good |

**Fig. 14A—Mag. 200X**

Structure of a weld on material 0.040 inch thick. This shows a small overheated area at the center of the weld proper where melting of the metal appears to have taken place.

gage, and it was necessary to compile a series of charts for welding of all gages, gages to like gages and unlike gages of different thickness for the entire range.

Table 1 is a sample sheet which shows the required set-ups for welding similar thicknesses from 0.005 to 0.005 to 0.040 to 0.040; note that the setting for welding 0.005 to 0.005 required a tip pressure of but 300 lb., while 0.040 to 0.040 requires 500 lb., the cycle setting varying from 1 on the 0.005 to 4 on the 0.040; heat 90 for the 0.005 and 70 for the 0.040. Also, note that these welds were well above the required pull test strength as designated by the Army and Navy.

Figure 1 shows the type of weld samples used in the following illustrations:

The sample is 1 in. wide, 6 in. center to center of securing holes and has a 1-in. plate lap, the spot weld being located at the center of the 1-in. square made by the lap on a line passing through the centers of the holes.

The clamps for holding the samples have a tempered pin which passes through the holes in the test sample thereby reinforcing the gripping faces of the clamp and insuring that the major strain is on a straight line through the weld center. A hydraulic jack with self-registering pressure gage is used and results obtained check very accurately with those made on laboratory equipment.

Out of thousands of microphotograph samples we have selected a few to illustrate different phases of spot welding and the difficulties encountered therein.

A 10% sodium cyanide solution has been used for etching and the black spot and lines seen in the illustrations are due to this etching reagent seeping out of the junction between the sheets and do not indicate a detect in the weld.

Figure 2 is a magnification of 50 diameters of 2 welds made on a stored energy welding machine with flat point electrodes.

The lower weld shows lack of sufficient heat, a slight fusion of the metals having taken place at the circumference of the weld and a slight tendency to fusion at the center.

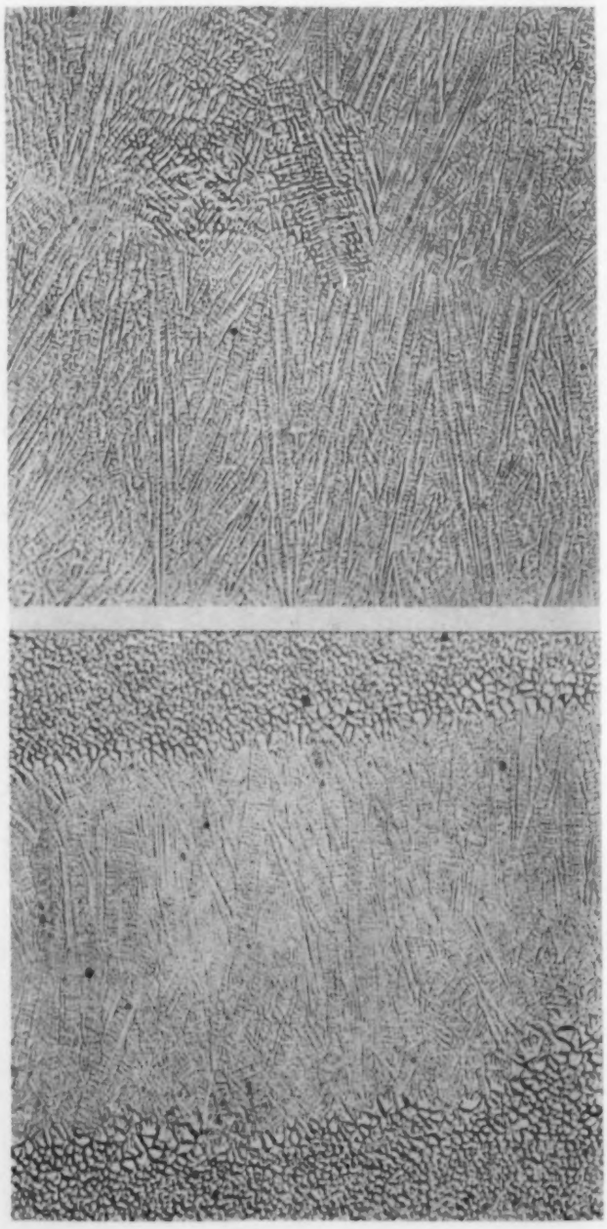


**Fig. 14B—Mag. 200X**

Similar structure of a weld on material 0.034 inch thick.

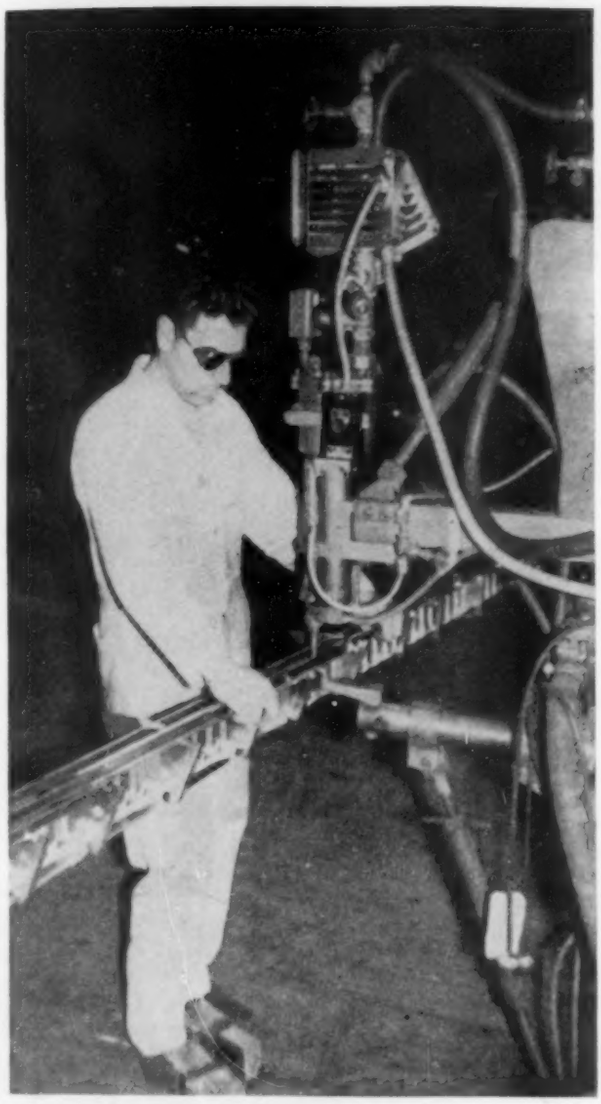


Fig. 15—Experimental Set-up

In the upper weld, where slightly more heat was used, there is good fusion of the 2 pieces at the outer edge of the weld, but absolutely no fusion through the center.

Figure 3 is a 200-diameter magnification of the section marked 649-A-11 at outer edge of the weld shows in Fig. 2 (*A*). It shows a very good fusion of the metals at this point, extending throughout the circumference of the weld.

Figure 4 is a 200-diameter magnification at the center of Fig. 2 (*A*) marked 649-A-12, and shows that practically no welding took place at this section of the weld.

In Figure 5, *B* shows a weld made between pieces of 0.010 stainless. Note that with the flat points the weld still tends to begin fusion at the periphery of the weld but still shows lack of sufficient heat for a satisfactory weld.

In Fig. 5 (*A*) the heat has been increased from 1600 to 1700 volts, the timing point pressure and other machine settings being the same.

This is a very satisfactory weld although still showing the hour glass shape and tendency to fuse more at the periphery than at the center, clearly indicating that with flat points the combination of heat pressure is greater at the outer edges of the electrode.

The next two figures will illustrate how a tip ground with a radius will overcome this by insuring that the weld builds from the center outward, thereby giving a more dendritic structure.

Figure 6 is a photomicrograph at 50 diameters taken through the center of a weld between 2 pieces of 0.015 stainless. Figure 6 (*A*) shows a near perfect weld made with tips having a crown with a 2-in. radius.

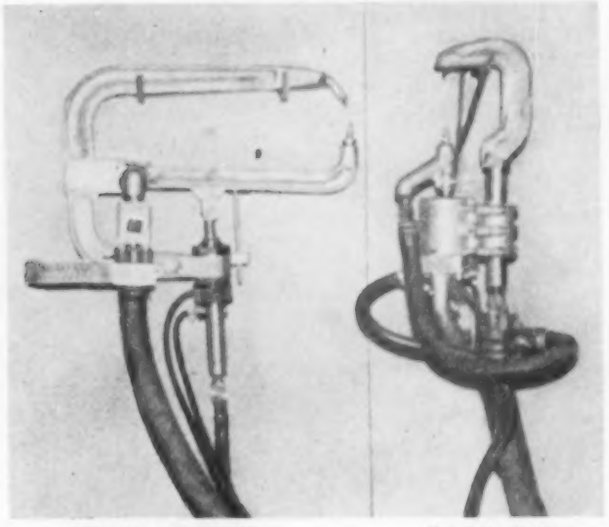


Fig. 18—Hydraulic Squeeze Gun

Fig. 19—C-Gun

**Fig. 16—Mag. 20X**

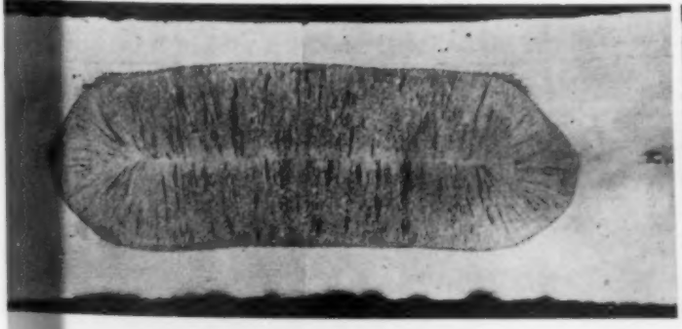
Spot weld made on full hard 18–8, 0.040 inch thick. This sample was welded on a synchronous timed resistance welding machine. The machine setting was as follows:

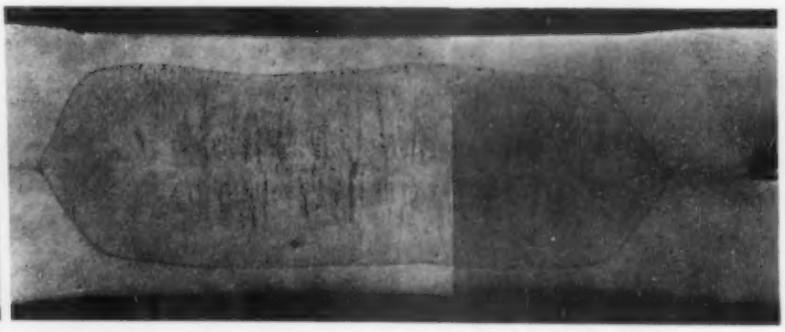
| Tap | Heat | Cycle | Tip diam. | Pressure | Pull test |
|---|---|---|---|---|---|
| 1 | 100 | 2 | 5/32 | 37,500 lb. | 2000 |

**Fig. 17—Mag. 20X**

Spot weld made on full hard 18–8, 0.040 inch thick. This sample was welded on a synchronous timed resistance welding machine. The machine setting was as follows:

| Tap | Heat | Cycle | Pressure | Pull test |
|---|---|---|---|---|
| 2 | 70 | 2 | 37,500 lb. | 2600 |





Note that the weld extends almost exactly 70% of the thickness of the 2 metals which has been proved to be an ideal depth for strength, surface smoothness and visual characteristics.

Figure 6 (*B*) is a section taken through the center of the weld after pulling. Note the excellent character of the shear, a button having been pulled from one of the sheets. The full strength of this weld was 575 lb., 20% above Army and Navy requirements.

It is interesting to see the absence of any tendency toward fusion from the circumference of the weld inward, as in all the welds made with flat tips.

Note carefully the settings required for the machine for this 0.015 material:

| Mfd. | Volts | Tip Press. | Tip Radius | Strength of Weld | A. & N. Req. |
|---|---|---|---|---|---|
| 53 | 1850 | 600 | 2 in. | 575 lb. | 460 |

Figure 7 shows a similarly perfect weld made between 2 sheets of 0.020 full hard stainless.

Figure 7 (*A*) is a 50 × photomicrograph through the center of the weld *before* pulling, and the lower Fig. 7 (*B*) is a similar picture *after* pulling.

Comparing the machine settings and physical characteristics with those in Fig. 6 we find:

| Mfd. | Volts | Tip Press. | Tip Radius | Strength of Weld | A. & N. Req. |
|---|---|---|---|---|---|
| 53 | 2700 | 700 | 2 in. | 875 lb. | 650 |

Note that while the microfarad capacity remained at 53 it was necessary to increase the voltage 30%, from 1850 to 2700 and the tip pressure 15%, from 600 to 700 to get a comparative weld. The strength of this weld, as can be seen, is 875 lb., or 20% over Army and Navy requirements, in direct proportion with the weld in the 0.015 material.

The next series of illustrations show welds made by the stored energy welding process with heavier gages of hard austenitic stainless, and further illustrates why flat tips are hazardous. Also they give further evidence of the tendency of the weld to reach a maximum at the outer edges of the electrode.

The granular structure of these welds is very plastic, and considered by some welding engineers as the ideal weld structure.

Figure 8 shows a 20 × photomicrograph through the center of a weld made between 2 sheets of 0.040–$^3/_4$ hard austenitic stainless steel.

The machine settings were as follows:

| Mfd. | Volts | Press. Turn | Tip Press. | Tip Diameter |
|---|---|---|---|---|
| 265 | 2300 | 172 | 1700 | $^3/_{16}$ |

Great care was taken to dress the tips as accurately as possible but note that while indentation marks outline the tip throughout on both surfaces, sufficient contact between the sheets to effect a weld was on one tip edge only. A peculiarity of this weld, which will be illustrated even more clearly in succeeding illustrations, is the tendency of the weld to extend to the distorted section at the outer edges of both the electrodes.

Fig. 20—Fuselage Structure on Internal Jig

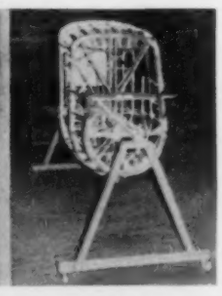


Fig. 21—End View. Fuselage

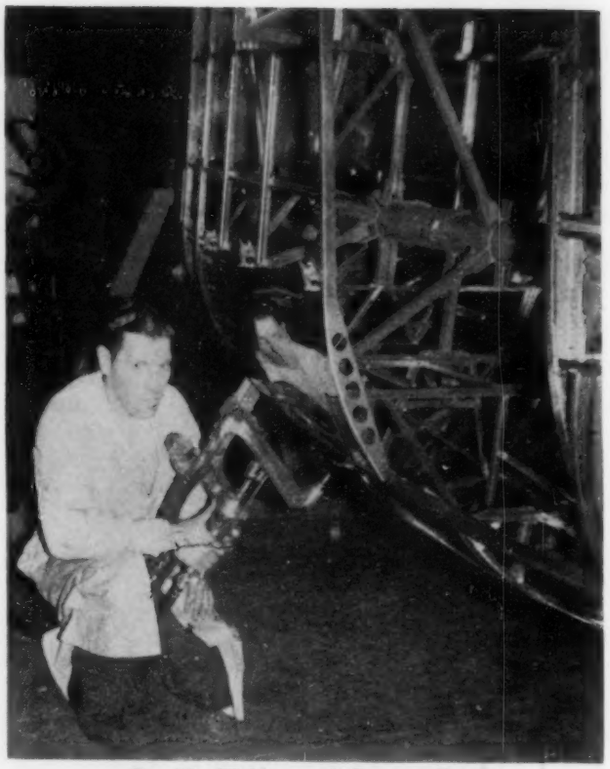


Fig. 22—Welding with Squeeze Gun

In Figure 9 exact settings were used, as in Figure 8, with the exception of an increase of 100 volts from 2300 to 2400.

The welded section has increased in diameter but is still more pronounced on one edge and the tendency of the weld to project to the surface at the circumference of the flat points is very pronounced.

In Figure 10 the tips were again carefully dressed, but with the same machine settings like results were obtained and the same tendency of the weld to extend to the surface at tip edges was apparent.

Figure 11 shows a weld made with the same machine settings but the tip was dressed off slightly on the side where good contact was shown in the weld illustrated in Fig. 10. This weld is nearly uniform but still shows the tendency to extend to the surface at tip edge. This weld shows a fine plastic structure with no dendritic tendency.

In Figure 12 the tip was dressed to a 4-in. radius and this fully eliminated an extension of the weld to the surface and made a much more uniform weld.

However, this figure illustrates another defect which occurs in stored energy welding if too much capacity and voltage is used, and no visual inspection or recording mechanism can determine same.

This defect clearly illustrated in the photomicrograph is an overheated section at the very center of the weld where the metal has been burned to a degree which has lowered its strength to a point where in pulling the weld it sheared along the line of the burned section, as illustrated in the lower figure.

The machine settings for this weld were:

| Mfd. | Volts | Tip Diameter | Tip Pressure | Tip Radius | Weld Strength |
|---|---|---|---|---|---|
| 212 | 2650 | $^3/_{16}$ in. | 1700 | 4 in. | 2100 |

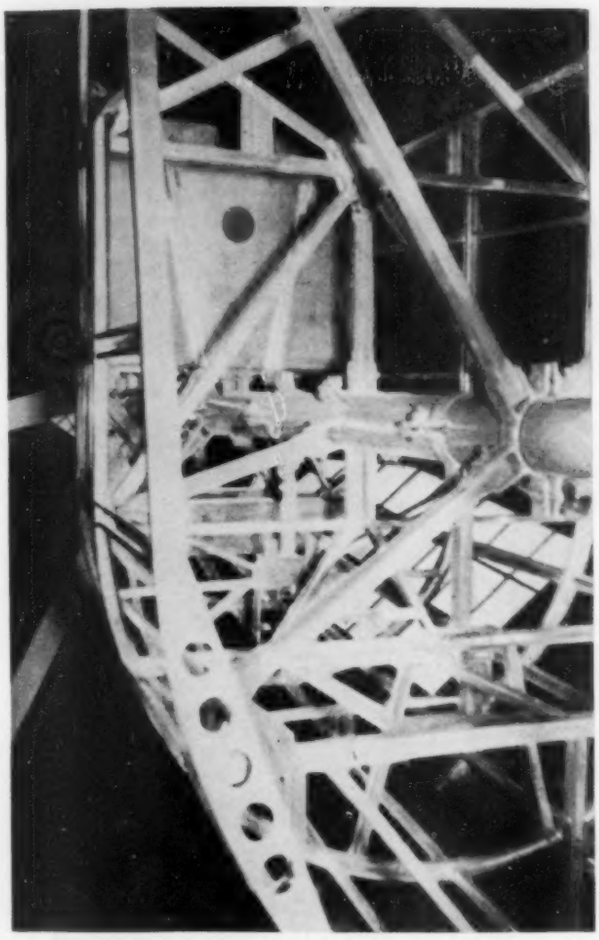


Fig. 23—Fire Wall and Engine Mount

It will be seen that this melting of the metal lowered the strength of the weld 700 lb., or 25% below that of the same size weld shown in Figs. 9 and 11, and even the partial weld shown in Fig. 8 pulled 2400 lb., or 13% more.

Still another variation of this type of defective weld is shown in Fig. 13 illustrating a 20 × photomicrograph of a weld between 2 pieces of 0.034 full hard stainless. This weld not only shows a badly burned area at the center of the weld but a clearly defined corona of carbon precipitation around the outer edge of the weld, and in testing, the weld pulled out along the line of the carbon deposit.

Figures 14 are photomicrographs of 200 diameters of sections 673-A-1 and 673-A-2 taken in the overheated areas. These pictures clearly show the rupture of the grain in this area due to excessive heat.

It must be borne in mind that all of the plates shown are from welded samples made on a pedestal welder under ideal conditions where the welded pieces were not only small, but in true planes. Under working conditions where *C* type and squeeze guns are used, a large percentage of the time, conditions for welding are in many cases extremely difficult and the hazards are multiplied many times.

It was for this reason that A.C. resistance welding has been found preferable to D.C. stored energy, on stainless steel aircraft structures by the concern in question.

Figure 15 is a view of the experimental set-up for resistance welding. In this photo can be clearly seen the attachments for hydraulic and air guns.

Figure 16 is a photomicrograph at 20 magnifications of a typical weld between 2 pieces of 18–8 stainless made on the pedestal setting of the above machine. This photo has been heavily etched to clearly outline the dendritic structure of the weld which shows a slight over-heating of the fused section.

Figure 17 shows another such weld with the heat reduced 30% giving a much more uniform structure and a perfect weld with a fine dendritic structure, and extending exactly 70% of the thickness of the 2 pieces, with the maximum width along the junction of the 2 welded pieces. These welds were made with tips crowned with a 2-in. radius.

While spot welding of stainless steel is a faster method of fastening than riveting, the jigging of the sub and major assemblies must be far more accurate as it is possible to draw surfaces together with rivets that cannot be spot welded, and in order to bring the work within range of the spot-welding equipment, highly flexible jigs must be used.

The following figures illustrate jigs for sub and major assemblies which are so mounted as to be portable and also allow the assemblies to revolve in the jig, bringing all parts accessible to the welding guns. These are good examples of practical adaptation of aircraft jigging for use with spot-welding equipment.

Figure 18 is a picture of a hydraulic squeeze gun designed for spot welding the skin to the fuselage framing. It has a 650-lb. tip pressure at 90 lb. air, and has a 20-in. throat and 6-in. gap. It is very light and easily handled by one man.

Figure 19 is a picture of one of the *C* guns designed for welding over deep frames. The tip electrode holder is adjustable and can be extended 6 in. to allow for the use of various lengths of tips. This type of gun is found very valuable for making welds in otherwise inaccessible places.

Figure 20 is a view of the fuselage structure mounted on its internal jig, removed from the external jig and ready for application of the skin. This jig also revolves and is portable by means of casters.

Figure 21 is the same jig taken from another angle with the fuselage revolved to an upside-down position for welding the roof-skin in place.

Figure 22 is a close-up view showing the accessibility of the frames for welding by squeeze guns.

Figure 23 is a fire-wall and engine mount at rear of the fuselage. The black spot at the center of the fire-wall panel is an application to prevent tin panning of the unsupported section.

Figure 24 is a picture of the outrigger and torque-box sections of the wing undergoing C. A. A. test on the test stand. This unit is withstanding an ultimate load plus 25%.

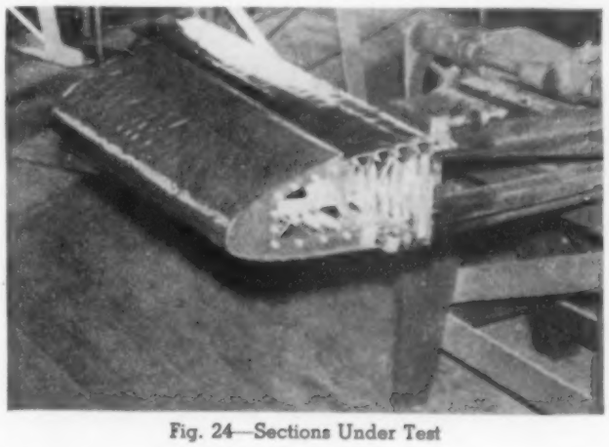


Fig. 24—Sections Under Test

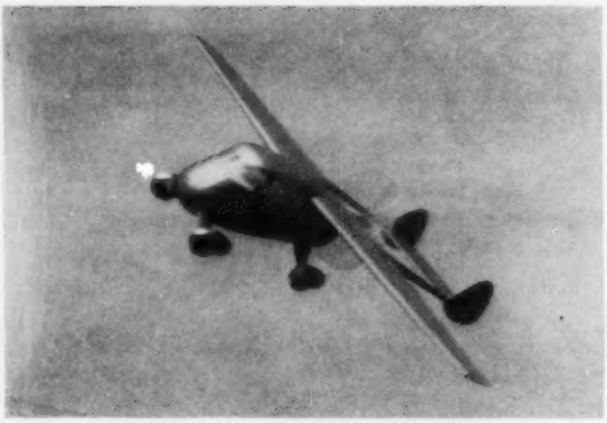


Fig. 25—Experimental Machine in Flight

Figure 25 is a view of one of the experimental four-wheel all stainless jobs as it appears in flight.

In conclusion some mention should be made as to the possibility of new spot-welding methods in the future as there are many people, especially among the metallurgists, who believe that the high pressures now used in stainless steel and aluminum alloy welding are unnecessary and are designing equipment in an attempt to prove their point.

One such laboratory in Detroit, with whose activities the writer has been in touch, is experimenting with a process which is best described as having functions analogous to those of a hydraulic ram. A $7\frac{1}{2}$-kva. unit has been equipped with an improved secondary winding whereby the total impedance of the circuit has been reduced and only slight losses occur even with a 6-ft. arm.

The power source is a 220-volt single-phase A.C. current fed by a 30-ampere service and an 8 to 1 ratio hand lever used for pressure. Some astonishing results in stainless steel welding have been accomplished on this machine, but the experiment has not yet been carried far enough to rate definite conclusions as to its possibilities.


### Acknowledgment

Many thanks to R. A. Lincoln of the Allegheny-Ludlum Company for his fine cooperation.


# Training Welding Operators for National Defense*


By James A. Waln†


WHEN an occupation, such as welding, becomes so vital to the fabrication of modern military equipment that a shortage of persons skilled in that occupation threatens to constitute a major bottleneck in the defense of the nation, a report on training to prevent that shortage appears to be timely. The following overview of the training of welders for national defense is therefore submitted with the hope of portraying its importance, its nature and its problems, through the presentation and discussion of the major aspects of the program.

It is felt that conclusions presented or intimated herein represent the experiences of the many welding supervisors and instructors with whom the author has associated since the beginning of our national defense training program.

### The Need for Training

The beginning of our national defense program found us at the end of a decade of depression and recession, during which time training in public and private vocational schools was greatly curtailed and training within industry was almost forgotten. As a result, we were faced in 1940–41 with a shortage of skilled workers, trainees and persons familiar with training procedures.

Welding is by no means the only job for which training is a vital necessity to our national defense, but the fact that it is employed somewhere in almost every defense industry, as well as its importance to a gigantic shipbuilding program, makes it a very essential one. For example, in the shipyards where there are one hundred and nineteen occupations and nineteen skilled trades, according to the Bureau of Labor Statistics, approximately 10% of the workmen are engaged in welding operations.

The growth of Germany's great war machine—the greatest the world has ever known—was made possible by a great many developments in manufacturing and assembly techniques. But without welding and welding "rod" such a machine could not hold together.

At the outset of the war, September 1939, Germany had 12,000,000 trained workers in her munition industries alone, and 800,000 apprentices in training. This, compared with our 4,308,000 workers and 125,000 apprentices, in defense manufacturing industries is indicative of the problem facing us at the outset of our program: namely, to equal and to surpass the wartime production schedule developed by Hitler over the previous seven years.

### Federal Aid

Among the steps taken by the Federal Government to aid defense industries in alleviating the shortage of skilled labor which was curtailing an accelerated production program, were:

1. The establishment of the Training Within Industry Section of the Office of Production Management, charged with the responsibility of assisting defense industries in setting up in-service or on-the-job training programs for introducing and upgrading employees.
2. The Congressional Appropriation of funds to the U. S. Office of Education for allocation to State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† Special Representative for Trade and Industrial Education, U. S. Office of Education.

vocational education authorities for the operation of courses in occupations essential to national defense.

The expenditure of these national defense training funds was authorized for the payment of the cost of two general types of occupational training of particular interest at this time:

(*a*) Supplementary courses for persons employed in occupations essential to national defense, or closely related occupations, for the purpose of improving their skill and knowledge.

(*b*) Pre-employment courses for persons selected from public employment office registers, who by such special training will be prepared for definite payroll jobs essential to national defense. So-called "refresher courses" are pre-employment courses for persons with previous experience selected from public employment office registers, who, when refreshed by training, will become qualified for employment in definite payroll jobs essential to national defense.

## Scope of Training

National defense training courses are carried on to meet specific needs in given localities and for more or less definitely defined jobs for which local industries have indicated their requirements. Intensive pre-employment courses of from two hundred to four hundred hours in length are designed to develop cutters, tack welders and welding operators who can lay down weld metal in a commercially accepted manner. Supplementary training courses are conducted for the purpose of up-grading welding operators after they have acquired some practice and experience in industry.

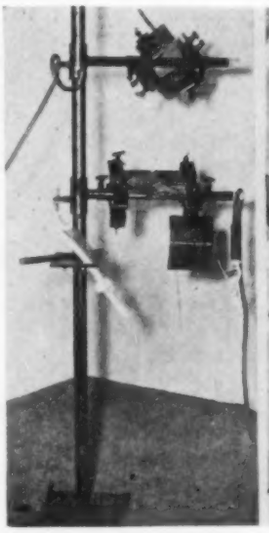
It is common practice for industries to hire welding operators from pre-employment courses and then to encourage them to return to the school two or three evenings per week for more advanced training. Frequently men are assigned to supplementary classes on company time.

To insure that specific courses are designed to meet the particular needs of local defense industries, defense training classes, for which funds have been appropriated to the U. S. Office of Education for allocation to vocational education authorities, are conducted by State and local administrators of vocational education, in accordance with a State plan for defense training, approved by the U. S. Office of Education, and with the consultation of State and local advisory committees composed of representatives of employers, labor and consultants from public employment offices and other agencies concerned. When it comes to determining even more specifically the content of a training course such as welding, a craft committee is generally employed.

In general, the training of welders has been for shipbuilding, aircraft and general fabrication and maintenance; with arc weld training predominating for shipbuilding, oxyacetylene for aircraft and combination courses for general fabrication and maintenance. Combination courses for beginners are generally looked upon with skepticism by supervisors, however. It is felt that they are likely to be the result of a lack of definiteness and purposefulness in planning. The greater proportion of pre-employment training in welding is for the shipbuilding industry. This is, no doubt, due to an accelerated building program and to the great amount of welding done on modern hulls and bulkheads. In the aircraft industry a much smaller percentage of the employees are engaged in welding and these are principally all-around welders who could not be developed in short pre-employment training courses. However, several schools are training aircraft tube welders, in pre-employment classes, for industries that have a sufficient amount of welded fabrication to warrant the degree of process breakdown and specialization of work necessary for employing specialized welding operators. There is also an increasing demand for welders in the manufacture of tanks and other motorized equipment.

The first problem in setting up courses of training for welders is to determine the type of welder desired. In developing the course, these five major divisions should be considered: welding practice, welding theory, interpretation of welding symbols, shop mathematics and length of time to complete the course. The training should be no more comprehensive than the welding job for which it is given.

In the training of operators, theory does not require much time, but attention to the reason for doing things in particular ways should be stressed. A few explanations of what takes place during welding and cutting are necessary elements in teaching welding practice. Instruction in blueprint reading is a necessary part of the training of welders whose employers require their making set-ups and welding directly from blueprints. Pre-employment training of welding operators generally



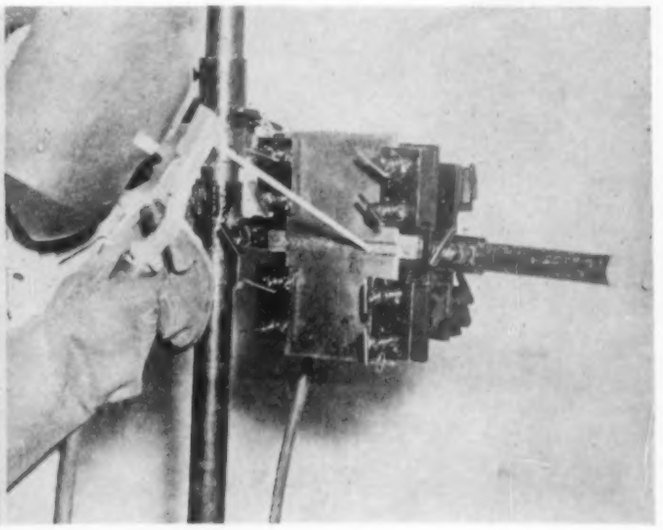


**Fig. 1 (Left)—This Jig and Stand Was Designed by H. K. Hogan of the U. S. Office of Education and Built by the Mastbaum Vocational School in Philadelphia**

Note the varied position in which metal to be welded can be held. "On the job" conditions can be simulated further by adjusting the height of the jig.

**Fig. 2 (Right)—A Close Up of the Jig in Use with Grooved Weld in the Horizontal Position**

Fig. 3—A Trainee Practicing the Corner Weld in Vertical Position

Fig. 4—A Defense Trainee Practicing the Corner Weld in the Overhead Position

requires little if any blueprint reading or mathematics. On the other hand, these subjects may form a very important part of an advance supplementary course. The length of time required to train a welder depends upon his aptitude and the welding job for which he is being trained, assuming, of course, that the proper equipment, supplies and instructions are provided. A finished operator cannot be turned out at the end of a brief period of training. However, it is possible to train a good welder for a particular class of work in a short period of time. For simple repetitive tasks, such as tack welding, eighty hours have been found to be satisfactory, and two hundred hours is sufficient time for surprisingly thorough training in broader fields. There is considerable difference of opinion among employers as to the length of training desired for new welders. One navy yard official has said, "Give me a man with aptitude and I can make a third-class manual arc welder out of him in one hundred and eighty hours." In this same locality ship-builders are hiring men with two hundred hours of training if they can pass the Guided-Bend Test. In another part of the country, ship-builders will not hire men without at least four hundred hours of training, regardless of their having passed the Guided-Bend Test. The men in charge of training must gear their programs to meet the specifications of local industry.

Instructors, supervisors and welding engineers have remarked on a number of occasions that the greatest difficulty with industry in general is a lack of supervision in welding. It is said that many employers not only expect a welding operator to deposit the weld metal but also look upon him as a welding engineer. The job is really a twofold one requiring, first, careful designing of parts and adequate preparation to permit the average welder to do a good job, and, second, the employment of the proper process of welding with a competent welding operator. Defense training courses of the pre-employment type cannot be expected to go farther than the development of skill in manipulating an electrode, obtaining through fusion, keeping the weld free from slag and recognizing conditions that may produce excessive porosity.

## Selection of Trainees

The paramount problem of welding schools today is to assist defense plants in increasing the abilities of their welders through supplementary training courses, and to furnish them with more welding operators through pre-employment courses. An extremely important first step in pre-employment training is the selection of trainees. If the trainees are of low intellect and poor aptitude, poor welders are most likely to be the result. It may be argued that only the very minimum of requirements are essential at this time because most of the training is for specialized operator jobs, but it should be remembered that the leading welders of tomorrow will come from today's reservoir of operators. Therefore, the future efficiency of the welding industry might depend to an important degree upon the intelligent selection of trainees today.

Students for pre-employment defense training classes, for which Federal funds have been appropriated, are referred to the schools by Public Employment Offices upon requisition from training officials. Initial selection is made from employment office registers on the basis of previous employment and training records, physical characteristics, and often with the aid of mechanical aptitude and mental tests. No standardized tests appear to have been validated for the selection of welder trainees, but there are some that may be employed as first screens, if used with discretion.

Although there are many variables that go to make up the potentialities of a prospective welder, observation and careful analysis lead us to believe that the more important factors to be considered when selecting welder trainees may be summed up in these four questions:

1. Is he trainable—can he learn?
2. Does he have sufficient mechanical aptitude and intellect to learn welding?
3. Is he physically equal to the job?
4. Does he have the right attitude?

In approaching an answer to these questions, standards may be set up according to the following outline.

*A*. Physical characteristics:
   1. General health and stature
   2. Eyesight

3. Hearing
4. Muscular disabilities
5. Irritability
6. Age

*B.* Mechanical aptitude:
1. Dexterity
2. Coordination of eye, mind and hand
3. Mechanical trend and interest

*C.* Intellect:
1. Ability to absorb information
2. Perception and visualization

*D.* Education:
1. Reading and comprehension

*E.* Attitude:
1. Toward work in general
2. Toward the work of a welder
3. Toward the company for which he is to be trained
4. Toward fellow workers
5. Toward superiors

Space does not permit a full exposition of the aforementioned factors in predicting probability of success on the part of prospective welder trainees, but a few brief statements may serve to indicate the importance of some points. Normal hearing is not only an important safety factor but an aid to the welder in recognizing some causes of difficulty by the sound of the arc in electric welding. Normal or corrected eyesight is essential to the welding operator in properly placing the weld metal and observing the quality of the work as he goes along. Dexterity is an important factor in the efficient handling of the welding torch and welding rod in acetylene welding and in handling the electrode in arc welding, as well as in getting into difficult positions so often required on welding jobs. Perhaps the greatest single determining factor in a welder's efficiency is whether or not his eyes, mind and hands are so coordinated that his hands will quickly follow the thoughts of his mind which have been stimulated through his eyes. Proper temperamental disposition and a spirit of cooperation on the part of a welder are important because of the necessity for him to work in close cooperation with others and often under none too comfortable conditions. Reports from welding supervisors and instructors indicate that men between the ages of 18 and 30 are preferred for training courses. Thirty to 35 years is claimed to be a fairly satisfactory age. As a man approaches 40 there is a general reluctance to accept him for training because experience has shown that he is not so likely to succeed as a welder.

**Fig. 5—Cutting and Burning Has Long Been the First Stage of Training for Oxyacetylene Welding Operators. After a Brief Period of Training These Men Will Go to Work in the Todd Bath Shipyards**

Compliments of the South Portland, Me. Vocational School.

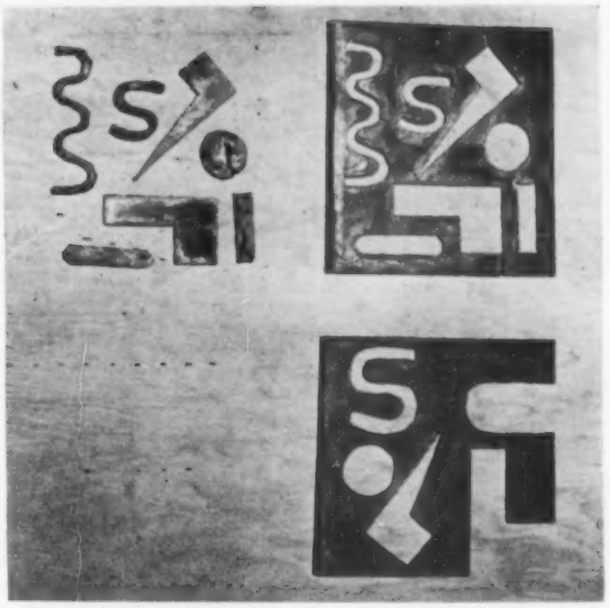


**Fig. 6—Oxyacetylene Cutter Trainees Are Required to Pass This Test Before Referral to Industry for Employment**

Compliments of the Philadelphia Board of Education, Vocational Education Division.

It is interesting to note that the training records of one large shipbuilding concern show failure on the part of only two out of eleven hundred men selected from the plant for training as welding operators. One hundred hours was the shortest amount of time taken by any one of those men to develop sufficient proficiency to pass the Guided-Bend Test in all positions, and qualify as a third-class welder.

## The Instructor

The quality of welding operator emanating from any training program depends a great deal upon the efficiency of the instructor. Too much stress cannot be placed upon the importance of his fitness. When equipment has been installed, supplies secured and trainees enrolled, the whole responsibility for developing proficient workmen rests upon his shoulders.

One of the big problems in connection with the training of defense workers today is that of obtaining competent instructors, both for training within industry and for training in vocational schools. Instructors for welding classes have, for the most part, been skilled men released from industry and given instructor training on the job in the welding schools. Defense industries are realizing more and more that the loss of a good welder to a training center is soon offset many times by the number and quality of welding operators his work as an instructor enables the school to prepare for the industry.

The instructor must be well founded in the specific skills and factual knowledge of the occupation. In addition he must have leadership ability and interest in his pupil, and above all he must be able to impart his skill and knowledge to the learner.

For any occupation the teaching process is essentially the same for all places and sizes of classes, in so far as imparting specific skills for factual information is concerned. A good instructor proceeds to organize and present his subject matter as follows:

*A.* Preparing the subject matter.
1. Analysis of the occupation

The first thing an experienced instructor

does is to make an analysis of the occupation to be taught, with the objective of determining the specific things the learner should learn to do and the information he should acquire. These things readily fall into homogeneous groups which are commonly called teaching units.

2. Organization of teaching units

The second step is to arrange the teaching units in the order of their learning difficulty. A practical rule in teaching is to proceed from the simple to the complex and from the known to the unknown.

3. Analysis of teaching units

Before attempting to help a learner to master any unit of subject matter the experienced instructor carefully examines the unit and isolates the teaching points involved, so that he can present the lesson step by step in natural sequence and without the danger of omitting important phases or overlooking difficulty factors.

*B.* Presenting the lesson to the learner.

Many volumes have been written on methods of presenting subject matter, but the steps in helping a learner to learn are essentially the following:

1. Preparing the learner

A good instructor first builds up interest on the part of the learner and leads him to understand just what it is that he is expected to learn.

2. Showing the learner

The instructor's next step is to demonstrate the exercise to the learner by performing it himself and explaining what he is doing and why he is doing it, as he goes along.

3. Helping the learner

At this stage of the presentation the learner is set to work practicing the exercise that has been explained and demonstrated to him, and the instructor observes the work at frequent intervals and corrects improper techniques.

*C.* Examination.

The final examination is a means of measuring the proficiency of a learner after he has finished a lesson or a course in order to determine a rating that will be indicative of the work he is prepared to do. However, tests and examinations have other functions that are pertinent during the teaching process. A good instructor is constantly observing and examining the work of the learner to determine which elements of the lesson have been mastered by the learner and which should be retaught. This is generally referred to as diagnostic testing or examination.

A very important function of the welding instructor is to foster the development of such habits and attitudes, on the part of the learner, as will result in his giving his work continual study and never letting himself get into the frame of mind of thinking that he is a finished product with no more to learn.

The AMERICAN WELDING SOCIETY's Committee on Minimum Requirements of Instructions for Welding Operators in Trade Schools in the preliminary draft of their proposed code, list the following "Duties of Supervisor," which appear to be very descriptive of the functions of one who is directly responsible for the instruction of learners:

1. Seeing that the student acquires safe working habits.
2. Demonstrating and explaining the techniques

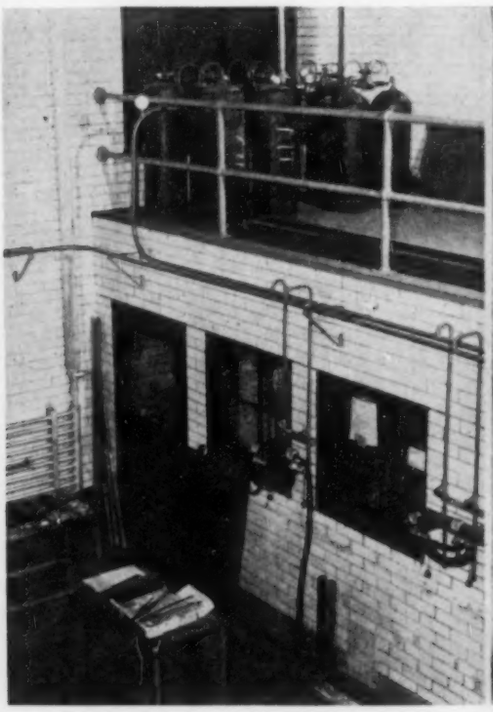


**Fig. 7—Good Shop Equipment and Layout Are Essential to Efficient Training**

The acetylene manifold and pipes of the Dickinson Vocational School, Jersey City, N. J.

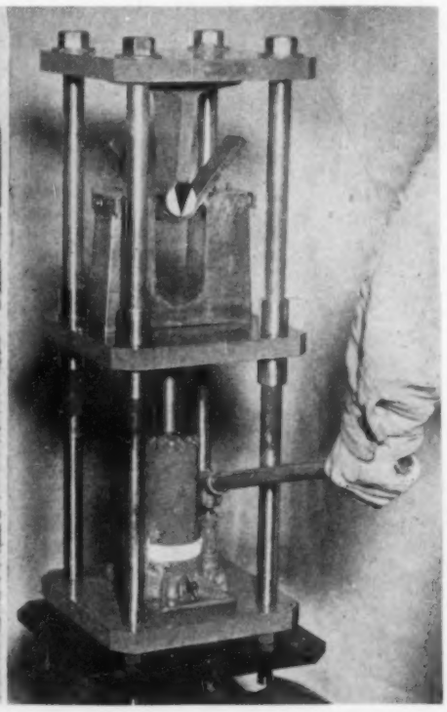


**Fig. 8—The Guided-Bend Test Jig in Use**

to be used in each exercise, before the exercise is attempted by the students.

3. Observing the work of each student at frequent intervals and correcting improper techniques.
4. Inspecting the finished welds and explaining to the student the nature and probable cause of any defects found.
5. Keeping a record of the student's progress.
6. Prescribing additional practice for students who require it in order to keep up with the class.
7. Answering student's questions relating to the work of the course.
8. Seeing that the student observes the school's safety regulations.

## Qualifying Tests for Welding Operators Other Than Aircraft

Testing welded specimens for soundness can be classified under two headings:

(*a*) *Fracture* or *Rupture Test.* This is sometimes called the "nick-break" test. The specimen is broken open and examined for complete penetration through the entire thickness of the weld and for excessive slag, oxide inclusions, gas pockets and other harmful defects. This test was found to be too subjective as it is extremely difficult to set up an acceptable definite measurement for the degree of permissible soundness. Therefore, it is rapidly being eliminated from codes for qualifying welding operators. It should, however, be used as a "check" test during instruction.

(*b*) The *Guided-Bend Test* is now the accepted type of operator qualification test and is designed to ascertain that the operator has a sufficient knowledge of, and skill to apply, a procedure of welding under average conditions. To the welding school, the test is an acceptable procedure for testing the trainee's ability to apply the experience and knowledge gained during his training, and to determine his fitness to enter industry as a beginner-welder on simple production welding.

The test requires that the specimen shall withstand bending through 180° in a special jig without developing cracks. The guided-bend tests are divided into two groups: (*a*) the "limited" qualification test on $^3/_8$-in. thickness material is for qualifying the operator to weld up to and including metal of $^3/_4$-in. thickness and requires the face-bend, root-bend and fillet soundness tests; (*b*) the "unlimited" test for qualifying beyond $^3/_4$ in. thickness is made on 1-in. plate and requires a side-bend test only.

The soundness tests for "limited" operator qualification are specially devised tests using two types of test plates: (*a*) groove welds; (*b*) fillet welds of special designs, that can be tested in a guided-bend test jig. The *fillet-weld* test plate is made on $^3/_8$-in. plates. The edges to be welded are square instead of beveled and the plates are arranged with a 2-in. backing strip and with a gap of $^{15}/_{16}$ in. between the two square edges. The operator makes fillet welds on each side of the gap between the edges of the plate and the backing strip is then machined off flush to the surface of the plate, *transversal to the weld*, and cut into two specimens. The grooved-weld specimens are made in flat, vertical, horizontal and overhead positions. Fillet-weld test plates are welded in a 45° tilted position for flat position welding, a 45° angle to the welding operator for vertical, in flat position for horizontal and in normal for overhead position welding. From each finished groove-weld test plate, one root-bend specimen and one face-bend specimen are made. From each fillet-weld test plate, two specimens are cut to be bent as a root-bend test only with the bottom of the weld specimen in tension.

It is now generally recognized that welding schools should confine their pre-employment training to preparing trainees to pass the "limited" qualification test on $^3/_8$-in. mild steel plate, using (for arc weld test) where possible a $^5/_{16}$-in. diameter, coated electrode of reverse polarity type to the AMERICAN WELDING SOCIETY specification, E-6010. However, for the fillet-weld test in the flat tilted position, a straight polarity electrode of the E-6020 specification can be used.

The training of welding operators for the "unlimited" or 1-in. plate test should be attempted only in supplementary or up-grading courses for welders who are able to pass the "limited" qualifying test and who have had a reasonable amount of experience in welding.

### *Aircraft*

In the aircraft industry governing bodies and manufacturers use many types of joints for qualifying welders. The most commonly used are:

(*a*) *Single Vee Butt Weld*, made with a single reinforcement which is machined off after the welding is completed and before the sample is cut up into three test specimens. A tensile test is made of each specimen and an average strength of not less than 90% of the tensile strength of the plate is required for the specimens.

(*b*) *Tubular Butt Weld:* This is an open butt weld made with tubes in a horizontal position for one specimen and in a vertical position for a second specimen. One set of horizontal and vertical specimens is required to be welded on the bench and one set in an overhead position. The specimens must withstand a test of 50,000 pounds per square inch for plane carbon steel and 80,000 pounds per square inch for alloy steel, calculated on the area of the base metal.

(*c*) *Vertical Fillet Weld*, made with plates standing on edge; pieces supported so that there is a clearance between one lower end of seam and jig; joint is tested in tension must develop not less than 10,000 pounds per linear inch for plane carbon steel and 15,000 pounds per linear inch for alloy steel; broken specimen is examined to determine fusion of weld into base metal in the corner.

(*d*) *Combined Plate and Tube Fillet Weld:* This is a three tube and plate and single plate joint. A transversal cut is made through the tubes and plate and either of the resulting halves is polished and etched with 50% aqueous hydrochloric acid at a temperature of approximately 180° F. (82° C.) for a sufficient length of time to bring out the boundaries between the weld metal and the base metal. Examination is made for freedom from blowholes and penetration of weld metal into the base metal.

Defense training schools should prepare trainees for qualification tests under the specific code used by the local industries for which they are training. However, reciprocal agreements are expected soon whereby welding operators in a given field who qualify for one Bureau or code body would be qualified for another. This would greatly simplify the problem of the schools in training welding operators for "limited" welding.

The Standard Procedure (1941) of the AMERICAN WELDING SOCIETY, Section I, Manual of Arc and Gas

Welding of Ferrous Metals, Part II, Operator Qualification, recently published by the AMERICAN WELDING SOCIETY, 33 West 39th Street, New York City, contains further details on the qualification tests for welding operators and can be secured for a nominal cost from the SOCIETY.

The Instructional Materials Division of the U. S. Office of Education has available, for distribution to welding schools, a pamphlet entitled "Arc and Acetylene Welding—The Guided-Bend Test—and a Suggested Design for a Guided-Bend Test Machine."

## Teaching Units

By far the greater proportion of the training of welders for defense is in the fields of manually operated arc and oxyacetylene equipment, although pre-employment classes, supplementary classes or on-the-job training might be found in any of the welding occupations. These are listed below with their corresponding code numbers from the Dictionary of Occupational Titles, Part 1, Definition of Terms, U. S. Government Printing Office:

| | |
|---|---|
| Welder, Acetylene | 4-85.030 |
| Welder, Arc | 4-85.020 |
| Welder, Atomic | 4-85.aa |
| Welder, Butt | 6-75.020 |
| Welder, Flash | 6-85.020 |
| Welder, Spot | 6-85.060 |
| Welder, Thermit | 6-85.070 |

The content of each of the foregoing occupations is indicated in the following outlines, which are based on information prepared by the occupational Analysis Unit of the United States Employment Service. It is intended that these outlines form the basis from which courses of study may be developed. Each major division of the outlines represents a teaching unit, or unit of subject matter, for which lesson plans could be prepared. More definite teaching material may be obtained through the Instruction Materials Unit of the U. S. Office of Education.

*Arc Welding*

I. Safety
- *A.* Fire protection
- *B.* Eye protection
- *C.* Clothing
- *D.* Health hazards and ventilation
- *E.* Care of equipment

II. Arc-Welding Equipment
- *A.* Operation and adjustment of welding machines
  1. Direct-current generator
  2. Alternating-current transformer
- *B.* Using auxiliary equipment and supplies
  1. Jigs and stands, electrode holders, bare and coated electrodes, testing devices and small tools

III. Welding Light and Heavy Metals

(Should be taught as two separate units—one for $^1/_8$-in. metal and below and one for $^3/_{16}$-in. metal and above)
- *A.* Flat welding
  1. Running straight beads
     - (*a*) Striking the arc
  2. Grooved butt welds
     - (*a*) Tack welding
     - (*b*) Single pass and multiple pass welding
     - (*c*) Single groove and double groove welding
  3. Fillet welds
     - (*a*) Lap welds
     - (*b*) Tee welds
     - (*c*) Corner welds
- *B.* Horizontal welding
  1. Groove welds
  2. Fillet welds
- *C.* Vertical welding
  1. Groove welds
  2. Fillet welds
- *D.* Overhead welding
  1. Groove welds
  2. Fillet welds

IV. Welding Various Metals
- *A.* Steels (metallic and carbon electrode processes)
  1. Tool steels
  2. Nickel steels
- *B.* Cast-iron
  1. Metal Arc electrode process
  2. Carbon Arc processes and bare cast-iron filler rod
- *C.* Malleable iron
  1 Metal Arc electrode process using reversed polarity
- *D.* Stainless steels
  1. Metal Arc electrode process using heavily coated rod
- *E.* Aluminum
  1. Metal Arc electrode process
  2. Carbon Arc process
- *F.* Manganese steel
  1. Metal Arc electrode process
- *G.* Copper
  1. Metal Arc electrode process
  2. Carbon Arc process
- *H.* Cast steel
  1. Using ordinary rods, bare or coated
- *I.* Monel metal
  1. Metal Arc electrode process
  2. Carbon Arc process
- *J.* Bronze (metal arc electrode or carbon arc process)
  1. Using coated or bare rods with reversed polarity
- *K.* Brass
- *L.* Everdur
  1. Metal Arc electrode process
  2. Carbon Arc process

V. Hard Surfacing
- *A.* Using self-hardening rods requiring no heat treatment
  1. Metal Arc electrode process
  2. Carbon Arc process

VI. Pipe Welding
- *A.* Fixed welds
- *B.* Rolling welds

VII. Structural Welding

VIII. Cutting
- *A.* Metal Arc electrode, process coated rod
- *B.* Carbon Arc process

IX. Testing and Inspection of Welds
- *A.* Soundness

1. Nick-break test
2. Guided-bend test
3. Fillet-weld-break test

*B.* Ductility
1. Free-bend test

*Oxyacetylene Welding*

I. Safety
- *A.* Oxyacetylene hazards
- *B.* Oxygen cylinders
- *C.* Acetylene and acetylene cylinders
- *D.* Combustion gas leak danger
- *E.* Welder's dress
- *F.* Eye protection
- *G.* Care in setting up, turning on gases, lighting torch and shutting down

II. Setting up Welding Equipment
- *A.* Placing and fastening tanks
- *B.* "Cracking" tanks
- *C.* Connecting regulators
- *D.* Connecting acetylene hose to regulator and torch
- *E.* Connecting oxygen hose to regulator and torch
- *F.* Opening tank valves
- *G.* Adjusting regulators

III. Lighting and Adjusting Torches
- *A.* Lighting the acetylene at the tip
- *B.* Adjusting the proper amount of acetylene for the tip size
- *C.* Adjusting the proper amount of oxygen

IV. Taking Equipment Out of Operation
- *A.* Turning off torch valves
- *B.* "Bleeding" hose
- *C.* Closing tank valves
- *D.* Removing regulator handles

V. Making Beads on Sheet Metal, Forehand and Backhand (in flat, vertical, horizontal and overhead positions)

VI. Making Tack Welds (in flat, vertical, horizontal and overhead positions)

VII. Building Beads on Sheet Metal with Filler Rod

VIII. Welding Joints (in flat, vertical, horizontal and overhead positions)
- *A.* Making butt weld
- *B.* Making flange weld
- *C.* Making outside corner weld
- *D.* Making inside corner weld

IX. Bronze Welding on Light Metal (in flat, vertical, horizontal and overhead positions)

X. Building Beads on Heavy Steel Plate (in flat, vertical, horizontal and overhead positions)

XI. Welding Sheet Metal and Heavy Steel Plate Together (in flat, vertical, horizontal and overhead positions)
- *A.* Making butt weld
- *B.* Making edge weld
- *C.* Making inside corner weld
- *D.* Making outside corner weld
- *E.* Making T-weld

XII. Making Beads on Cast Iron (in flat, vertical, horizontal and overhead positions)
- *A.* Building bosses
- *B.* Filling holes
- *C.* T-joint welds

XIII. Welding Lead and Lead Alloys (in flat, vertical, horizontal and overhead positions)

XIV. Welding Copper and Copper Alloys (in flat, vertical, horizontal and overhead positions)

XV. Welding Cast and Drawn Aluminum (in flat, vertical, horizontal and overhead positions)

XVI. Pipe Welding
- *A.* Fixed
- *B.* Rolling
- *C.* Building beads on various sizes of pipe
- *D.* Butt welding various sizes of pipe joints

XVII. Making Boiler Welds (in flat, vertical, horizontal and overhead positions)
- *A.* Single V-butt weld in $^3/_8$-in. metal
- *B.* Double V-butt weld in $^3/_4$-in. metal
- *C.* Heavy ribs on thick boiler plate

XVIII. Welding Thick Heavy Steel with Joints on Both Sides (in flat, vertical, horizontal and overhead positions)

XIX. Cutting Steel (by hand and with pantograph)
- *A.* Cutting low carbon steel
- *B.* Cutting alloy steel

XX. Hard-Surfacing
- *A.* Cast steel
- *B.* Cast iron
- *C.* Alloy steel

*Atomic Welder*

The essential difference between atomic-hydrogen arc welding and ordinary arc welding lies in the fact that a hydrogen flame envelops the arc and prevents oxidation and scale formation on the welded surfaces. The techniques of an atomic welder are somewhat of a combination of those of the arc welder and the acetylene welder, in that he uses both gas and an electric arc. Unlike the arc welder who usually uses direct current the atomic welder uses alternating current; and unlike the acetylene welder who uses oxygen and acetylene gases, the atomic welder uses hydrogen, which, in addition to supplying heat, obviates the necessity of using flux. (Hydrogen is also used in gas-cutting torches when used under water.)

The manipulation of atomic welding apparatus can be learned by a welding operator in a few hours, but to learn metals and their behavior requires from six months to a year of training. Atomic welders are generally trained on the job or in supplementary courses.

The following fundamental prerequisites of the trade may be taught to qualify an operator for skilled status as an atomic welder:

1. Welding of aluminum, duralumin, nickel, monel, copper, brass, bronze, chrome-steel, nickel-steel and molybdenum.
2. Operation of automatic and manually controlled machines.
3. Use of $^1/_{16}$-in., $^3/_{32}$-in. and $^1/_4$-in. tungsten electrodes.
4. Working knowledge of metallurgy, such as annealing, hardening, tempering and properties of alloys.
5. Welding of armaments—specifically guns, cannons, tanks and ships.
6. Job shop welding of many types of articles, on various metals or alloys, using different types of welding, performed in different welding positions.

*Butt Welding*

The occupation of butt welder is essentially one of operating an electric-welding machine that creates a difference of electrical potential between adjoining ends or edges of metal objects, which generates heat that melts and fuses the objects together. Men who have had some machine shop experience or trade training can become quite able operators in one to three weeks. In general most of the training is done on the job, although vocational school training and experience in general welding principles are advantageous. The following is indicative of the training content of the occupation:

*A.* General principles of the butt-welding process

*B.* Machine operation
1. Machine set-up
2. Adjustment of carriage and stops
3. Replacing and repairing attachments
4. General maintenance of moving adjustable parts

*C.* Requirements of different objects being welded, with respect to the heat current and duration of various phases of the process

*D.* Types of machines and processes applied in butt welding
1. Resistance butt welding
2. Flash butt welding
3. Upset butt welding
4. Clamping equipment
5. Pressure applying equipment
6. Timing equipment

*Flash Welding*

The training of men to operate flash-welding equipment, of the type in which a movable electrode travels along a seam to form a continuous weld, is generally given on the job to workers already experienced in kindred occupations. Reports indicate that it is possible to train a good operator for repetitive tasks in eighty hours, and for extensive welding practice, welding theory, blueprint reading and shop mathematics two hundred hours will provide sufficient training for this semi-skilled job and give a sound basic training for more advanced welding operations.

I. Welding practice

*A.* Types of automatic-electric arc welding equipment
1. Fully automatic equipment
2. Stationary or movable (mounted carriage) metal arc (bare or shielded wire), carbon arc or union melt

*B.* Set-up of machine in preparation for welding operation
1. Use of blueprints or charts

*C.* Types of welds made with automatic arc-welding equipment
1. Butt
2. Corner
3. Edge
4. Fillet
5. Plug
6. Built-up surfaces
7. Special

*D.* Kinds of products
1. Automobile housings
2. Boilers
3. Bridge floors
4. Cabinets
5. Tanks
6. Railroad cars
7. Others

*E.* Kinds of metal
1. Steel (mild, stainless, etc.)
2. Brass
3. Copper
4. Everdur
5. Monel
6. Nickel

*F.* Range of thickness

Thicknesses from 20 gage to 3 in. and over are in common use. Versatility on the part of the operator is very desirable since there are frequent changes in the work pattern and considerable initiative is required to devise means for holding and guiding the materials. Production line plants usually require only repetitive work on comparatively few patterns.

*Spot Welding*

The following training phases are intended to cover spot welding in a general way. Since they are not restricted to any particular type, style or make of machine, or any particular phase of work, a specific training course may cover only a few of the factors indicated.

*A.* Set-up and maintenance of the welding machine, including such elements as:
1. Shaping, inserting and clearing the electrodes
2. Setting up and repairing the timing devices
3. Adjusting and repairing pressure attachments
4. Adjusting flow of water for cooling electrodes

*B.* On hand-operated and foot-operated machines:
1. Learn exact pressure to be exerted by the electrodes on the metal in order to prevent burning through the metal or making insecure welds. The pressure is in direct proportion to the degree of heat and therefore the learner must develop the proper muscular discrimination in foot (foot-type) or hand (hand-type) to exert the correct pressure.
2. Develop hand and eye coordination on hand-type machines.
3. Develop hand, eye and foot coordination on foot-type machines.

*C.* Familiarity with working characteristics of metals:

For example, welding of aluminum alloys differs from that of steel, since the former has a very short plastic range. On the other hand, all non-ferrous metals are more difficult to spot weld because of metal pick-ups.

*D.* Recognition of different gages of metal:

Very thin foils require low currents, whereas plated ($^1/_4$-in. and over) require high currents.

*E.* Blueprint reading:

In some instances the teaching of blueprint reading is essential because the type of work requires it for setting up parts and locating welds.

*F.* Examination of welds.

*G.* Fitting materials to be welded into the machine.

*Thermit Welding*

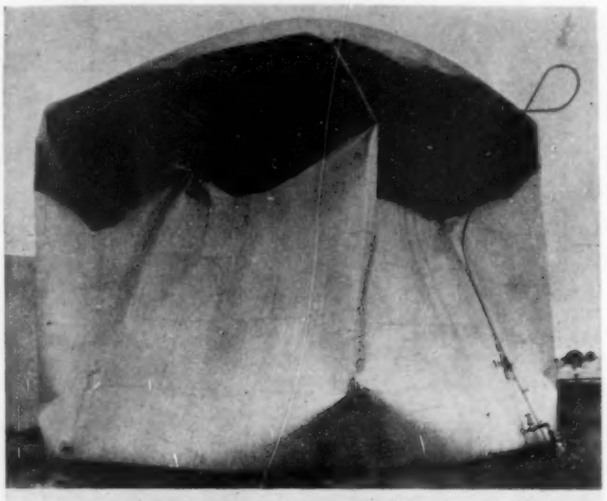
Training in thermit welding is generally given on the job to the selected workers who have already had experience on other welding or foundry jobs. The length of time required to develop a thermit welder varies from eighty to two hundred hours, depending upon whether he is to be used for simple repetitive tasks or for more varied work.

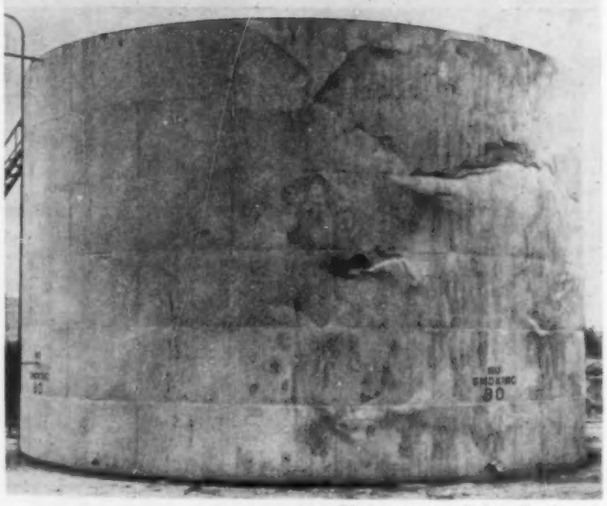
# Welded Tank Accident

By H. P. Rigsby*

THE advantages of arc-welded construction for oil storage tanks were vividly displayed in the freak accident to a 1000-barrel tank owned by Eastern States Petroleum Company of Texas. The tank was damaged severely, as the picture shows, by a vacuum formed when the vents failed to work while the fluid was being pumped out.

**Tank After Accident**

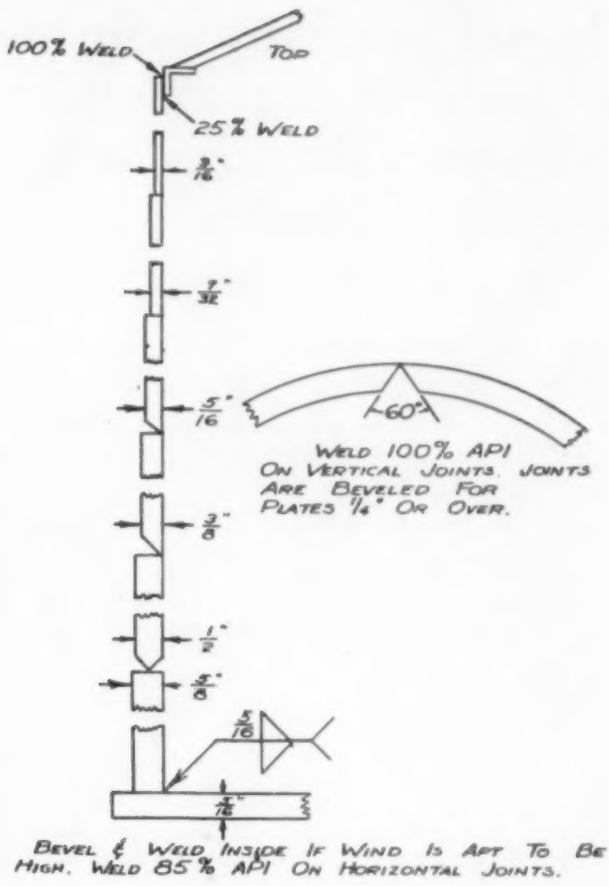




*Photos courtesy Hobart Brothers Co.*

**Tank Straightened by Water Pressure**

If this tank had been of riveted construction, there would have been nothing else to do but cut down the tank and rebuild it completely. As the tank was of welded construction throughout, repairing it was a simple operation. Water was simply pumped into the tank under sufficient pressure to force the plates out straight. Not one joint failed, as the picture clearly illustrates.




**Details for Butt-Welded Tank**

Riveted tanks have to be recaulked at least once each year, and after five or six years of use even that doesn't do much good. In comparison, welded tanks give leak-free service year after year.

Cost data listed below are based on construction of 80,000-barrel storage tanks. On an average, with a crew of one foreman and fifteen men, 15 days are required to erect a tank of this size by welding and 35 days are required by riveting.

| | |
|---|---|
| Welded Construction | |
| 1050 man hours at $1.50 per hour | $ 1,575.00 |
| 1200 man hours at $0.75 per hour | 900.00 |
| Steel and overhead | 33,000.00 |
| Total Cost of Welded Construction | $35,475.00 |
| Total Cost Riveted Construction | $60,000.00 |
| Savings from Welded Construction | $24,525.00 |

Preparation of the plates for riveting is a major item. Each plate has to have rivet holes punched or drilled—this cost being almost equal to the cost of the entire welded construction. In welded construction, plates over 1/4 in. are very quickly prepared by machine torch cutting. Plates 1/4 in. and under require no preparation at all. Sketch shows joint detail for butt-welded tanks.

* M. E. Department, A. & M. College of Texas.

# Metallic Arc Welding Used in Fabrication Special Swing Frame Grinder*

By John S. Green†

A SPECIAL type of swing frame grinder was needed to grind unfired pressure vessels built in accordance with A. P. I.-A. S. M. E. Code. The shells for these vessels consist of rolled steel plate, flanges and nozzles fabricated by the arc-welding process. Code requires longitudinal and circumferential seams to be welded from both sides of plate. Shop practice is to run outside beads as first operation; then this bead is chipped from inside to remove slag, followed by application of inner bead as the final welding operation. This inner bead must be ground to contour of shell, in order to provide clearance for tube bundle which is to be inserted.

This grinding operation was performed by use of 1 x 6-in. emery wheels driven by air motors. As an improvement Hi cycle grinders were tested, but found too heavy to handle when grinding the inside of cylindrical shells.

As shells were to be ground on internal circumference, the conventional type of swing frame grinder could not be used. A grinder for this requirement must be constructed with grinding wheel revolving in the same direction as drive shaft. No suitable machine could be located on the market.

Prices submitted for building a suitable type of drive ran from $700 to $1000 with eight weeks' delivery. It was decided to design and build the required machine in our shop of welded construction and an appropriation of $600 was approved to cover cost of same.

A 2-in x 12-in. emery wheel at 2000 r.p.m. was selected as correct size to cover the range of shell diameters. A 3-hp., 1430-r.p.m., 25-cycle, 3-phase, 220-volt motor was selected as the driving medium. The over-all length was set at 8 ft. with a 40-in. reach into the shell, when supported by special built jib crane.

As the main member of the grinder frame, a seamless drawn tube $3^3/_4$-in. O.D. x $2^7/_8$-in. I.D. was taken from stock. With exception of motor, bolts, gaskets and ball bearings, all other material was taken from steel racks. As this grinder had to be operated from rear of wheel, three horizontal handles of cold-rolled steel $^3/_4$ in. x 36 in. were welded to the tube. Sketch shows the general assembly.

* First Prize Winner—Hobart Arc-Welding News Contest.
† Works Manager, Johnson and Jennings Company, Cleveland, Ohio.

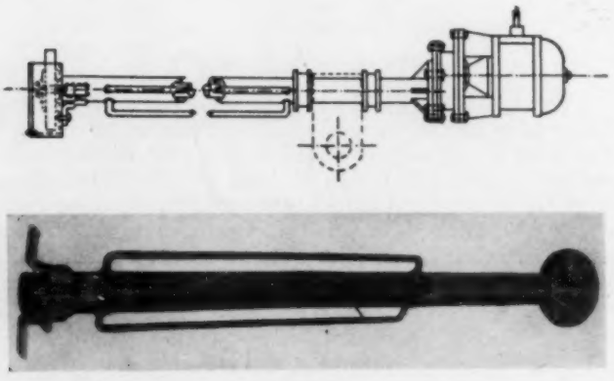
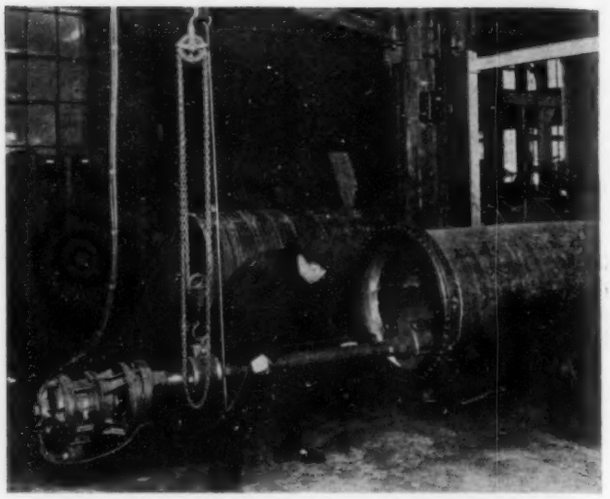


Fig. 1



Photos courtesy Hobart Brothers Company

Fig. 2

Due to limitations of 25-cycle motor speeds, it was necessary to use gears to secure correct speed of wheel. This was accomplished by application of herringbone gears set in gear case as shown. The offset motor support drops the center of gravity of frame to point where friction generated by wheel in grinding will not cause it to revolve in the bearing support, yet same is easily oscillated as operator follows circumference of shell. This offset weight brings machine back to normal position where operator released pressure on handles.

The support consists of a split cast-iron collar, with frame oscillating in ball bearings. Set collars are applied so that operator may adjust center of balance to suit grinding requirements.

Frame housing is bored for radial and thrust bearings to support drive shaft.

Wheel guard is fabricated from section of 14-in. pipe and two $^1/_2$-in. steel plates. Grinder is suspended by chain hoist to jib crane. When not in use a suitable hook engages with eye bolt on wheel guard to keep wheel from resting on floor.

Cost of building the swing frame grinder as illustrated is as follows:

| | |
|---|---|
| Material: | |
| Steel bearings and gears | $ 56.17 |
| 3 Hp. motor and controls | 176.00 |
| Direct Labor: | |
| Welding, 18.3 hrs. @ 0.90 | $ 16.47 |
| Machine, 98.4 hrs. @ 0.75 | 73.80 |
| Assembly, 32.6 hrs. @ 0.70 | 22.82 |
| Shop Cost | $345.26 |

This special swing frame grinder replaced three small air grinders. The advantages obtained by welded construction allowed for reducing clearances to a minimum and gave required rigidity with less weight than could have been secured by any other method of fabrication. The lightness of the machine gave the required flexibility and speed in operation.

Cost sheets show a 27% reduction in over-all grinding costs on heat exchanger shells, by use of this swing frame grinder, which replaced three conventional type air grinders.

# Bridge Welding*

By T. H. Gardner†

THE construction of all-welded bridges, especially railway structures, has been very limited in this country. We will briefly describe the all-welded railway bridge structures on the main line of the Florida East Coast Railway Company.

## Girder Span Pacet Channel Viaduct

In 1933 serious cracks developed in one of the concrete arches in the Pacet Channel viaduct near Key West. Design and shop details were prepared for a shallow and narrow all-welded girder span, 50 ft. long, to set in between the arch walls and rest on new bridge seats cast on the piers. Invitations for proposals on the fabrication of the girder span were sent out, requesting alternate proposals to meet the physical requirements. The welded design developed to be the most economical and was ordered. The span, 50 ft. long, consisted of two 36-in., 300 pound wide flange beams with cover plates top and bottom. The top cover plate extended full length and the bottom cover plate as well as the Tee section laterals were tapered at the ends.

During construction the ballast and sand were removed and floor beams shallowed at the ends set on the arch walls carrying stringers. This temporary construction was all welded from second-hand material in stock. An open deck was applied and traffic was carried on this at a restricted speed until the new span was set. Welded built-up pedestals were used.

## Double Track Bascule Span, Jupiter, Florida

In 1935 the superstructure of a modern double track riveted bascule railway span, 50-ft. horizontal opening, was demolished in our bridge over the Loxahatchie River near Jupiter, Florida, Fig. 1. This was caused by a train running onto the partially open draw. Fortunately, no one was seriously injured. This was a modern bridge, having been in use about 10 years.

The design and details were available for the superstructure. Detail drawings were hurriedly prepared, using the same design loading for an alternate welded superstructure. It developed that the power plant, some of the machinery and some of the castings were undamaged and available for re-use. The plans for the riveted span and the alternate welded span were sent out, inviting proposals on the fabrication and erection. This developed that the welded job which had approximately 25% less tonnage was more economical.

Contract was let for the fabrication and erection of the span, which was shop assembled and the field holes reamed or drilled while in place.

The counterweight boxes, which were 10 x 20 ft. and formerly field connected, were shop welded to the girders. This required very accurate work as the welding of the counterweight boxes established the lining up of the trunnions. The trunnions were assembled on the counterweight boxes and the counterweight boxes welded to the main girders. The exact line was checked during welding. Care was exercised, but no difficulty was experienced in properly executing this work. About 350 manganese steel rivet bolts were used in the preliminary field erection. Otherwise all field connections were welded.

The girders were erected in a down position and the change-over was made in about seven hours. In addition to the holes for connecting the span to the castings, racks, etc., which holes were common to both welded and riveted construction, the welded details had about 350 bolts and about 800 holes, while the riveted job had about 18,000 rivets and 50,000 holes.

## All-Steel Open Deck Single Track Trestle Approaches Stuart, Florida

In 1937 it became necessary to rebuild the temporary trestle approaches to the new bascule span of our bridge

Fig. 1—Superstructure Double Track Riveted Bascule Span Demolished

* Presented at the Annual Meeting, A. W. S., Philadelphia, Pa., Oct. 20 to 24, 1941.

† Structural Engineer, Florida East Coast Railway Company, St. Augustine, Fla.

Fig. 2—All Welded Single Track Steel Trestle Approaches to Bascule Span at Stuart, Florida. Length 1200 Ft.

over the St. Lucie River at Stuart, Florida. Although the bascule was double track it was decided to construct single track approaches. Alternate continuous and simple span girders were used, using one-ply 36-in. wide flange beams, Fig. 2. The 3-span continuous girders were 80 feet long, the mid span being approximately 30% greater than the end spans. Cantilever brackets were built on the ends of the continuous girders with narrow pads welded on to carry the end reactions from the simple spans, Fig. 3. The simple spans were shallowed at the ends by removing a section of the web and bending up the flanges so the ends of the simple spans could be carried on the cantilever brackets. The bents generally consisted of four 14-in. bearing piles. The cap consisted of two 18-in. channels back to back with cover plates.

*Pedestals*

The design throughout was to provide narrow bearings and secure concentric loading. The pedestals were made with a narrow pad on top and the load carried by two stiffeners which met at the top and spread out at the bottom to carry the reaction to the backs of the channels of the caps.

*Provision for Tolerance*

Provision for tolerance in the location of the bents in relation to the girder stiffeners was made by making some of the pedestals eccentric. The simple spans were provided with two sets of end stiffeners so that the reaction could be applied through either set or applied between them.

*Girder Details*

End cross-frames were made of 21-in. wide flange beams with stiffeners extended top and bottom. Intermediate stiffeners were made, using 8-in. wide flange beam at the top with brackets portal shape to brace the bottom chord. All cross welding in tension was avoided. Stiffeners framing into tension chords were welded to a diamond shape pad which was welded to the chord, avoiding an abrupt change in section. All top lateral bracing were 8-in. and 10-in. Tees tapered at the ends and connecting to gusset plates welded to the webs of the girders. The lateral bracing was dropped down about 8 in.

*Pile Details and Pile Driving*

The base of rail is approximately 13 ft. above mean low water, which is more or less salt. The depth of the river was a maximum of 25 ft. The bottom is composed of a layer of muck or unstable material with underlying sand, shell or gumbo in various combinations. Seven test piles were driven to a bearing load of 90 tons by a double-acting hammer. Two plain piles were driven, spliced and driven to minus 101 and minus 108 ft. below mean low water. The balance of the test piles were lagged with tapered timber lagging which was secured by welding on plates. This lagging was 18 ft. long applied at the tip end. A heavy base plate was welded on to protect the tip end of the timber. This detail provided a tapered displace-

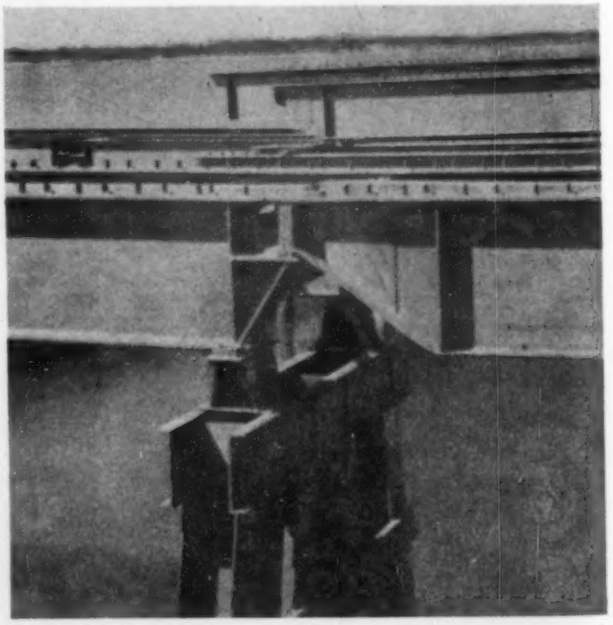


Fig. 3—Cantilever Brackets Built on the Ends of Continuous Girders

ment pile of cross section 15 x 15 in. at the tip and 15 x 24 in. at the top of timber. The lagged piles drove to an average depth of minus 50 ft. or about 50 ft. shorter than the plain piles. In the construction all piles were lagged. It was necessary to bury the lagging into the sand to prevent destruction from marine borers.

*Pile Protection*

Wrought-iron sleeves approximately 6 ft. long to fit the pile section were fabricated and, after piles were in their final position, were welded in place to extend about 3 ft. above and 3 ft. below mean low water.

*Fabrication at the Site*

Detail plans were prepared for the superstructure. Invitations for proposals on furnishing the girders and pedestals were sent out. The quotations received were considered too high. Study then made developed the economy of constructing a temporary fabricating plant at the site solely for the fabrication of the material for this job.

*Temporary All-Welded Fabricating Plant*

A spur track from the main line existed which ran down to the river. Additional temporary tracks were installed and overhead gentries built. A narrow erection shed 132 ft. long with crane runway was built, using 6-in. stanchions and 5-in. purlins. A 90-lb. rail was used for the crane beams. Hand hoists, crane ends and trolleys were purchased.

The entire fabrication was performed at the site with the exception of planing the pedestals. Welding machines were rented. A portable automatic flame-cutting machine was used in most of the flame cutting. No forges, drill press or air compressor were used. Electric chipping hammers and electric grinders were used. The entire personnel in the shop with the exception of the writer were employed solely for the one job and none of the skilled workers were railroad men. When fabricated the material was rolled on push cars to a track which extended on a temporary dock. The driving of piles and the erection and painting of steel were by contract.

It was recognized that in general it would be entirely uneconomical to construct any temporary plant such as this for one small job, but it was considered that the prices asked for the work were entirely beyond reason. It was estimated that we should save 15% by the fabrication. After all costs, including a loss of over 50% on all equipment purchased, were charged off, the saving was 18% under the lowest proposal on the fabrication.

## Open Deck Double Track Railway Trestle Over San Sebastian River, St. Augustine

In 1940 it became necessary to rebuild the existing railway bridge of the Florida East Coast Railway Company carrying main line traffic over the San Sebastian River at St. Augustine, Florida.

After a study of the most economical structure, the design adopted was an open deck double track arc-welded steel railway trestle E55 loading. The structure, 250 ft. in length, consisted of 21 bents, each carried on four steel pipe lagged piles, Fig. 4. The piles were slotted at the top after driving and clamping to receive the stem of a $13^1/_2$-in. Tee section cap, this cap being a 27-in. wide flange beam at 187-lb. split. The four lines of 12-in. 133-lb. wide flange beam stringers were spaced 6 ft. 6 in. centers, being the same spacing as the piles. The base of rail being only about 9 ft. above mean low water, the deck was made as shallow as practical. The piles were driven plumb into a sand and shell bottom.

No bracing was provided in the bents, except the end bents which were buried in the embankment fill. To provide the necessary lateral strength and stiffness, a truss was formed of the outside stringers and lateral bracing. This lateral bracing was composed of 4-in. Tee sections tapered at the ends and connected to the webs of the stringers at their center of gravity. This construction provided a horizontal truss 19 ft. 6 in. deep and 250 ft. in length to distribute any lateral forces to several bents and/or to carry it to the end bents.

The end bents were braced both laterally and longitudinally. The stringers were fully field spliced to form continuous beams (and chord sections) the entire length of the structure. The south end bent was braced to a tower bent just beyond the structure, and the north end bent was braced longitudinally by struts connecting to a pipe deadman encased in concrete. Provision for expansion of the deck was made at either end bent and an auxiliary transverse truss was installed at each end to distribute the end reaction of the truss.

*Fabrication*

All fabrication was done by arc welding. The fabrication of the stringers and end walls was performed at a regular fabricating plant.

*Pipe Pile Detail and Fabrication*

Ten-inch extra heavy seamless steel tubing together with the other necessary material was purchased by the railway and delivered to the site. The pipe was ordered in 20 ft. and 40 ft. random lengths, and fabricated at the site by contract into 40, 60 and 80 foot piles, Fig. 5 (*a*). Timber lagging was applied to the pipe section for a

Fig. 4—Welded Steel Railway Trestle

Fig. 5(*a*)—Fabrication of Pipe Pile

Fig. 5(*b*)—Timber Lagging Applied to Pipe Pile

distance of 12 ft. at the tip or bottom end by welding on 4 $3^1/_2$-in. angles longitudinally equally spaced, making a $10^5/_8$-in. square section, Fig. 5 (*b*). A base plate was welded on closing the end. Wings or guides of angles were welded to the square section and tapered timber 2 x 10 in. tapered to 4 x 10 in. was applied to the four sides. Plates were welded to the wings, securing the green pine timber. This provided a displacement tapered pile at the lower end.

The driving developed the length of piles required which was about 45 ft. As the driving progressed the 80-ft. piles were cut off to 55- and 60-ft. lengths before delivering them to the driver. As a matter of information two plain piles were driven and incorporated in the bridge. The average length of the plain piles was over 100 ft. as compared with 45-ft. average length of the lagged piles.

*Construction*

All field welding was let by contract. Another contract covered the erection.

The construction started October 1, 1940, by the driving of a temporary trestle. The driver then worked back, pulling the temporary piles and driving the permanent piles. The driving of the permanent piles started November 1, 1940, and was completed December 1, 1940. The bridge structure was ready for traffic February 1, 1941.

We consider that our development in arc-welded structures has been conservative and gradual. We previously had successfully and economically used arc welding in the strengthening, alteration and repairing of bridge structures. The writer has personally performed the design (with the exception of the bascule span), prepared or approved all shop detail plans, made all inspection and acted as resident engineer on construction.

In the past eight years more than 97% of the tonnage of the new bridges done by the Florida East Coast Railway Company has been done by arc welding. During that time, our strengthening of bridge structures and fabrication of steel buildings has been 100% by arc welding.

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## BOUND VOLUME JOURNAL

The American Welding Society has made arrangements for members who wish to have their Journals for 1941 bound in attractive, imitation black leather covers, to do so by sending copies of the twelve issues to Russell-Rutter Company, Thirty-Third Street and Eighth Avenue, New York, N. Y., Att. Mr. Russell Lauben, Jr. A special reduced rate has been arranged at $2.50 per volume providing the issues of the Journal are sent to the binder on or before Jan. 15, 1942. The bill for the binding and return postage will be sent direct from the Society's office.

# THE AMERICAN WELDING SOCIETY

## ACTIVITIES — RELATED EVENTS

### THE PRESIDENT'S MESSAGE

During periods of war, leadership is an essential qualification through which national unity is exercised. Normally, one thinks of leadership in terms of a single individual from whom commands issue.

There is in a democracy another type of leadership which may be even more powerful. It is the leadership of a group with common interests whose policies are decided after discussion and conference and whose actions are planned in agreement. Some of these groups are working for the common good and offer no direct benefits to those participating. For some, the objective coincides with the policies of National Defense. Within this small group lie our technical societies.

Our technical societies are organized for and active in the dissemination of technical knowledge and in promoting education, standardization and research. Men of interests centering about a product or a process meet and work together. In the national organization each phase of its activity is directed by groups representative of all interested parties. In each significant industrial community there is a mechanism through which these societies act.

In technical societies such as the AMERICAN WELDING SOCIETY there exists a living organism devoted to the common good. All of them are conscious not only of their duties to National Defense but also of their ability to exercise leadership in their field of activities.

Whether directly requested or not, this leadership can and must be exercised—always directed toward carrying out our national policies. Its influence will be as powerful as the experience and wisdom of those who direct its activities.

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### EXAMINATIONS FOR SCIENTISTS

Scientists have contributed much to the public welfare in peacetime. Today they have a vital part in the Nation's defense efforts. The knowledge and technical ability which chemists and physicists possess are in urgent demand in both industry and the Government service in solving defense problems. Defense problems are problems of modern mechanical warfare methods.

In an effort to meet the increasing need for these scientifically trained men and women in the Federal Government, the Civil Service Commission has reannounced, with modified requirements, its examinations for Physicist, Chemical Engineer and Explosives Chemist. The Commission is contemplating reannouncing other examinations with similar modifications. The salaries in each of these three fields range from $2600 to $5600 a year. For all, appropriate college study and experience are required.

Under the announcement the Physicist examination admits applicants for the assistant grade of positions ($2600 a year) who may qualify on college teaching unaccompanied by research. There is an especial need for the Physicist who is a "gadgeteer"—one in the field of electronics and radio physics to work in laboratories in producing both mechanical and electronic equipment. Modern warfare calls for mechanical devices—so-called servomechanisms—and the people who have the famed Yankee ingenuity which will produce these devices.

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### RESISTANCE WELDING CONTEST

The Resistance Welder Manufacturers Association has again set up a fund to be distributed in cash awards for technical papers on the general subject of "Resistance Welding." Being well pleased with the results gained in the first two years of this contest, the association has set aside for the 1942 contest one thousand dollars ($1000) to be distributed as cash prizes as follows:

For the best paper submitted, $500; for next best, $250; for next best, $100; for three next best, $50 each, making a total of 6 prizes.

It will be noted that the allocation of prizes provides for more attractive awards than was the case for the two previous years, through which it is hoped to attract still better papers.

In order to have these papers properly judged by entirely disinterested people, the AMERICAN WELDING SOCIETY will appoint a committee of three (3) judges to judge these papers and make the awards.

This contest, will run from September 1, 1941, to July 31, 1942, and the winners will be announced at the annual meeting of the AMERICAN WELDING SOCIETY in 1942.

The rules of the contest are published in the Year Book. It is contemplated that any paper on any subject dealing with Resistance Welding submitted from the U. S. A. or the Dominion of Canada, whether by a member or a non-member of the AMERICAN WELDING SOCIETY, or from any member of the Society anywhere in the World, may be entered in this contest. All papers submitted to the annual meeting of the AMERICAN WELDING SOCIETY may also be entered in this contest.

### COMMUNICATION TO THE EDITOR

**Subject—Resistance Welding**

October 31, 1941

Dear Mr. Spraragen:

The volume of research work in the resistance welding field during the past few years will be more than doubled in 1942. Results from such welding research are proving of immense value in meeting the speed requirements of our National defense program, and will be of primary importance in the subsequent adjustments during the economic crises that will follow. The theories worked out in the research laboratories are being applied in a practical way in every field in industry to manufacture products of much higher quality and at lower costs. Through a continuation of resistance welding research we can anticipate a steady improvement in the quality of products fabricated by the resistance method of welding. Manufacturers of resistance welding equipment by applying the findings of the research laboratories, will undoubtedly build machines of a higher standard of efficiency than ever produced before, which will not only be of great assistance to industry in the United States, but will be superior to any other resistance welding equipment in the world. There will be closer cooperation among the engineers who design resistance welded structures, the research laboratories and the welding engineers. Without any question of doubt, I predict more progress will be made in the use of resistance welding in 1942 than has been made in the last three years.

Very truly yours,
*Joseph W. Meadowcroft*

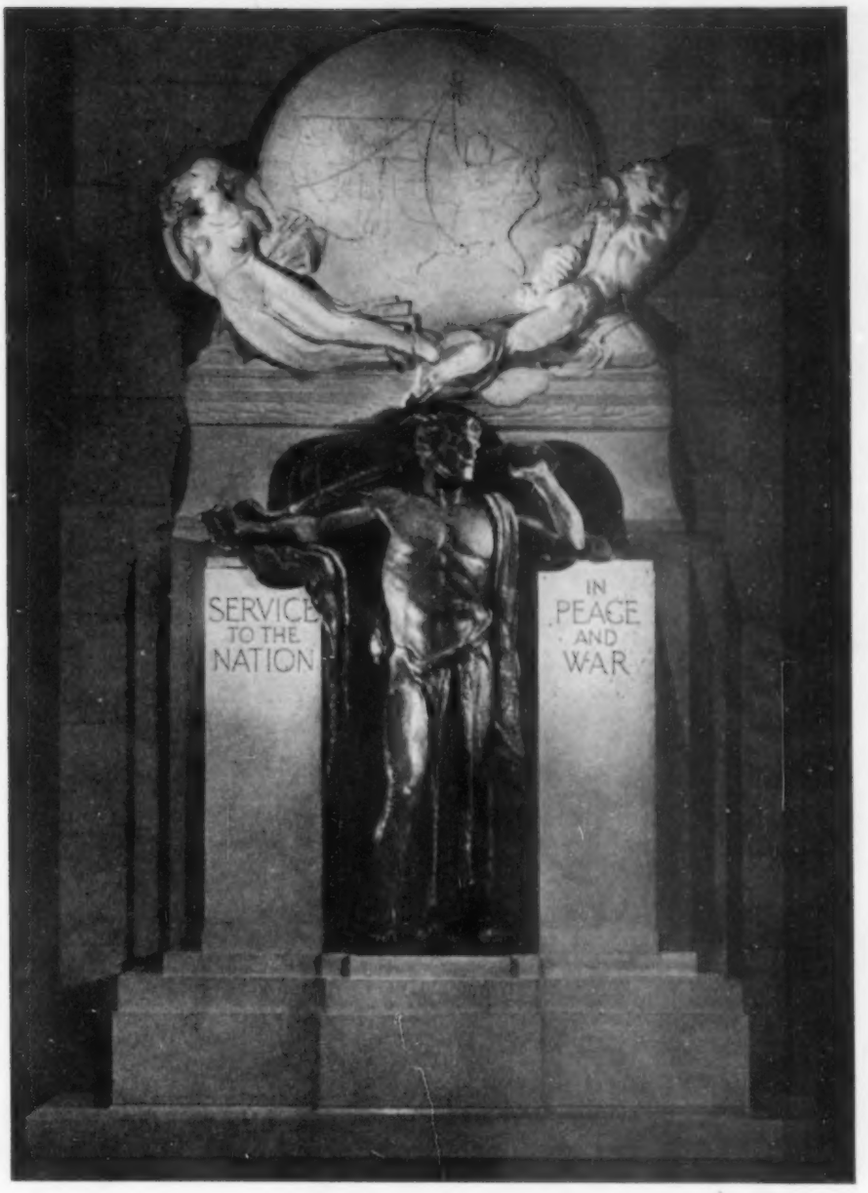
---

### JACOBUS HONORED

A dinner honoring Dr. D. S. Jacobus, retiring chairman of the Boiler Code Committee of the American Society of Mechanical Engineers, and his successor as chairman, Edwards R. Fish, was held Monday evening, Dec. 1st, at the Engineers' Club, 32 West 40th St., New York.

Dr. Jacobus has been chairman of the committee since 1936. Mr. Fish, chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., has been vice-chairman. Henry B. Oatley, vice-president, the Superheater Co., New York, N. Y., becomes the new vice-chairman of the committee.

Dr. Jacobus will continue as a member of the Boiler Code Committee and chairman of the Executive Committee. He




# "Service to the nation in peace and war"

Following the last World War a bronze and marble group was placed in the lobby of the American Telephone and Telegraph Company building in New York. On it are inscribed these words, "Service to the nation in peace and war."

They are more than words. They are the very spirit of the entire Bell System organization. In these stirring days, we pledge ourselves again to the service of the nation . . . so that "Government of the people, by the people, for the people, shall not perish from the earth."

*BELL TELEPHONE SYSTEM*

became a member of the advisory committee to the Boiler Code Committee in 1911, and was appointed a member of the main committee in 1915. He has served as chairman of the Executive Committee since 1917.

Mr. Fish, the newly elected chairman, has been a member of the committee since 1918, and a member of the Executive Committee since 1922. Some 60 people including members of the Boiler Code Committee, the Council of the A. S. M. E. and representatives of cooperating organizations were present.

---

### ELECTRODE BULLETIN

Arcos Technical Bulletin No. 5. Welding with Arcos Stainless Electrodes. Welding Air Hardening Steels with 25/20 Electrodes. Tables showing current values, weld metal characteristics, deposition data, heat treatment and applications of Arcos Stainless and Alloy Electrodes. Arcos Corp., 401 N. Broad St., Philadelphia, Pa.

---

### HEATING AND VENTILATING RESEARCH

A. E. Stacey, Jr., Chairman of the Committee on Research, announces the release of a 48-page booklet, *Programs of the Research Technical Advisory Committees of the American Society of Heating and Ventilating Engineers.*

This booklet contains the personnel of each committee, a briefly stated scope of activity, a comprehensive outline of planned research investigations, available laboratory facilities, a list of publications emanating from each committee program, and typical illustrations showing equipment in the several research laboratories. A bibliography of research reports is also included, together with regulations governing committees.

A limited number of copies of the booklet are available and may be obtained upon request from the American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York, N. Y. Also reprints of many of the research reports listed in the bibliography are available for distribution at a nominal cost of ten or fifteen cents each.

---

### LOW TEMPERATURE WELDING

In the actual emergency, machine designers, engineers and production men are confronted daily with new problems and very often welding will be the solution for these problems. The process consists of applying, with an acetylene torch, specially adapted alloy rods at low temperature, far below fusion temperature. The alloys closely match the parent metal.

In order that production men may have a complete literature on hand covering this process and all its possibilities, a new Technical Data Book on the *Low Temperature Welding Process with Castolin Eutectic Alloys*, has just been published. The new book not only gives a complete description of all new alloy rods, but gives important information in connection with work on national defense in fabricating machined parts, replacing castings, forgings and stampings. It further deals with salvaging work on defective castings, as well as aluminum and bronze, nickel, nickel silver, malleable iron, alloyed steel, and particularly for cast iron. The book contains 32 pages and has many helpful illustrations. It will be sent free of charge to all readers upon request.

---

### PROCESSES FOR WELDING PARTICULAR METALS

Clarifying the proper welding process for a particular metal under various circumstances, a clearly written, conveniently grouped, 55-page book, *Welding Procedures*, has just been published by Air Reduction, 60 East 42nd St., New York, N. Y. Single copies are available on request.

Strong, fast, economical welds can be made only by a welder who has a complete knowledge of the factors involved in welding the particular metal he is joining. *Welding Procedures* gives the reader the full benefit of Air Reduction's long experience in oxyacetylene and electric arc welding, brazing, etc.

In addition to recommending process, the book recommends the best filler metals to be used for each process, and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ECONOMICAL
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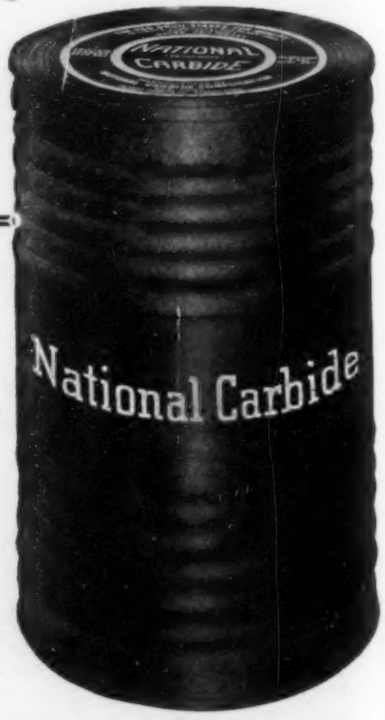


FOR WELDING and CUTTING
Use National Carbide in the Red Drum
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## For Smoother Arc Action

THE coating on Ampco-Trode aluminum bronze rods has been improved to give smoother arc action. Even inexperienced welders can now obtain satisfactory deposits —beads that adhere better, with slag that is easily removed.

Ampco-Trode is made with the properties of Ampco Metal, and contains all the wear-resistant qualities of this remarkable aluminum bronze alloy. Made in six grades, with hardness from 100–375 Brinell, Ampco-Trode has a tensile strength from 50,000–80,000 p.s.i., and compressive strength from 119,000–171,000 p.s.i. It is suitable for metallic arc, carbon arc, and oxyacetylene welding. Ask for our new Ampco-Trode bulletin which gives all the facts.

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Department WJ-142 Milwaukee, Wisconsin

**USES** It is suitable for overlaying steel and cast iron, building up shafts, wear strips, forming and drawing dies, refacing for extreme wear-resistance.

**SIX SIZES** Ampco-Trode is made in six convenient sizes—from 1/8" to 1/2" in diameter.

**RESISTANT** to wear on sliding surfaces, fatigue, impact and corrosion.

describes specialized welding techniques not commonly known. In an appendix, data are given for the calculation of electrode and gas welding rod consumption for different types of welds; also comparative welding record sheets for tabulating data that will determine the best welding method for a particular job.

Metals are grouped alphabetically under such headings as Aluminum, Die Cast Metals, Malleable Iron, Steel, Wrought Iron, etc. For each analysis of each metal (such as high carbon steels, medium carbon steels, low carbon steels) recommendation of process, of filler rod and special technique are given.

The book will awaken welders to the fact that where a choice exists between two or more processes the operator is prone to use the process in which he is most adept, without stopping to consider the ultimate cost. By use of the cost data sheets in the book and by gaining a keener appreciation of the fields for which gas or arc welding are particularly fitted, the operator will be able to produce better welds at less cost.

---

### CHAMBERS RETURNS

Gordon H. Chambers, Vice-President of the Foote Mineral Company, has recently returned from a three weeks' trip to South America. This is Mr. Chambers' second trip to South America via Pan-American Airlines in two years. In contrast to his previous trip, when he visited six countries, his second itinerary included the coastal and interior sections of Brazil. Business connections of the Foote Mineral Company afforded him the opportunity to make a comprehensive inspection of the varied and thriving mining operations in these regions.

---

### ACETYLENE COMPANY OF UTAH

Opening of the Acetylene Company of Utah Nov. 8, 1941, was to D. S. Jenkins the realization of a dozen years of dreaming and planning.

The plant is located at Salt Lake City, Utah. The company will manufacture acetylene gas, a product of calcium carbide, and will sell welding equipment, oxygen and carbide.

Early in the spring of 1942 the Acetylene Company of Utah will build an Oxygen plant of latest design.

---

### COMPOSITE STEELS

By T. S. Fitch*

In the year 1929, Jessop Steel Company instituted a program of research in connection with the combination of dissimilar steels, or "Composite" steels.

The primary efforts were directed toward the production of composite steels by casting one metal onto another, and the first product offered commercially was composite die section steel. Composite die section steel is an L-shaped section having tool steel in the corner of the land. Composite die section steel is especially suitable for sectional dies for the cutting of irregular shapes of sheet metal.

Concurrently, work was being carried on in connection with the joining of stainless steel to mild steel to form a product now familiarly known as stainless-clad steel. In 1935, arrangements were concluded to produce stainless-clad steel under U. S. Patent Nos. 1,997,538 and 2,044,742.

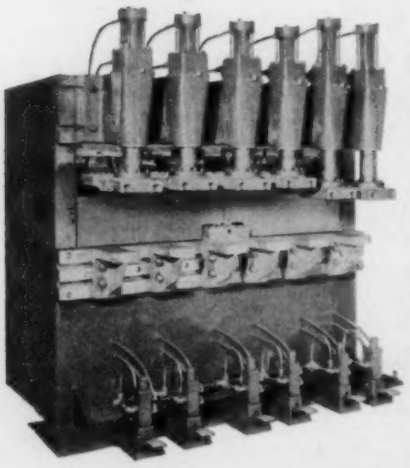
Essentially, the process is a diffusion welding system. In all the experiments it was observed that the invisible oxide on the surface of the stainless steel was the chief deterrent. In this diffusion-welding process, all such oxide is first removed by anodic pickling after which pure iron is deposited by electroplating on the clean surface of the stainless steel to the extent of approximately 0.012 in. The iron-plated stainless steel plates are then joined to mild steel by heat and pressure—essentially a simple operation. During the heating, rolling and annealing processes, diffusion takes place so that the ultimate union is an alloy zone having greater strength than the original deposit of iron and of sufficient strength to withstand any conditions in commercial service.

To date, stainless-clad steel is produced primarily in plate and sheet form. How-

* Manager, Composite Steel Division, Jessop Steel Co., Washington, Pa.


**Let an ACRO HYDRAULIC Solve Your Welding Problem**

Does your work require several projection welds at a time? If so, here is a six-station hydraulically operated projection welding machine which will do the trick.



This machine has six independent work stations, each controlled by its individual operating valve, The heads and knees are adjustable laterally to accommodate varying sizes of work. The transformer has a capacity of 350 k.v.a. The controls consist of an ignitron tube contactor, pneumatic welding period timer, eight point heat regulator and accessories to provide a complete machine. Rigid construction. Weight is about three tons.

**ACRO WELDING MANUFACTURING CO., INC.**
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SPOT, PROJECTION, SEAM AND GUN WELDING MACHINES

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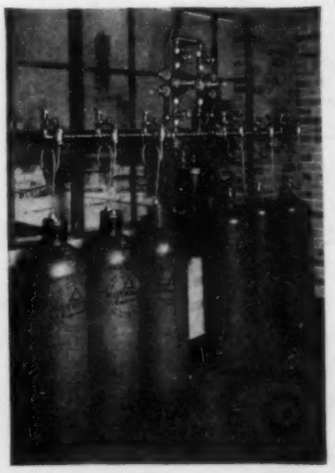

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4241 PETERSON AVE. CHICAGO

Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

*how a half hour huddle licked weld porosity*

IN the present crisis the immediate correction of production welding troubles is imperative—whether they involve changes in technique to speed up production or to eliminate flaws in the finished weld.

That is where your nearest Murex representative can be of help.

In one shop, for instance, difficulty was being experienced with weld porosity in oil storage tanks made from salvaged wrought iron. Our engineer quickly traced the cause to the use of excessive welding current, which was resulting in trapping slag from the iron in the welds. A change in procedure, calling for lower currents and involving downhill welding, eliminated the trouble by making it necessary to advance the electrode more rapidly. Thus, heat input was reduced and the building up of high beads prevented. At the same time, previous production speed was maintained.

Wherever the Murex organization can be of assistance in speeding the output of materials, either for direct or indirect war requirements, it is anxious to help—whether or not you are now a user of Murex.

When you are stumped by a welding problem, you will find invaluable our Murex engineers' knowledge of welding procedure, weld design and shop practices.

METAL & THERMIT CORPORATION 120 BROADWAY, NEW YORK, N.Y.

*Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.*

ALBANY • CHICAGO • PITTSBURGH • SO. SAN FRANCISCO • TORONTO

**MUREX**

**ARC WELDING ELECTRODES**

ever, strip and tubing have been made which were of satisfactory quality; certain production difficulties must and, no doubt, will be overcome in due course so that these forms will become commercially available.

This same diffusion-welding system has also been successfully adapted to the production of Composite Tool Steels.

---

## WELDED GUN CARRIAGES

Carriages for the 155 mm. gun pictured below are being manufactured by Pettibone Mullikin Corp. of Chicago on a regular assembly line basis. Production is organized so that a force of 350 men can easily maintain a schedule of 40 complete units monthly.

Most steel used in carriage is Low Alloy Hi Tensile—special steel being used only where necessary. Most of the steel is obtained already fabricated, the balance being flame cut according to master templates. All joints are scarfed either 45 or

60° in accordance with data from the Rock Island Arsenal, who were pioneers in construction of this type.

Tack welding and short seam welding is all done manually, using 13–18 carbon reversed polarity rods to give maximum ductility. Welding positioners, as shown in the picture above through courtesy Hobart Brothers, Troy, Ohio, are used extensively. Positioning has improved welds to such an extent that X-ray testing is practically eliminated, except, of course, where spot checks are made to insure against human element errors. Longer welds are tested with Magna-Flux method.

The finished carriage with the gun mounted is subjected to a 1000-mile road

test, and preliminary results show an average of 33 miles per hour, with a top speed of 75 m.p.h. For firing, rear wheels are removed and left and right trails are spread out so that entire carriage is lowered to the ground.

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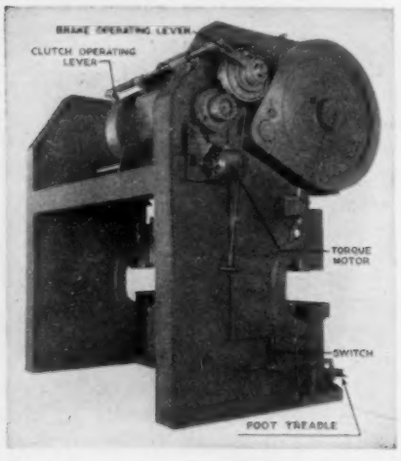
## CLUTCH AND BRAKE MECHANISM

A new electrically operated clutch and brake mechanism has recently been developed for Steelweld Bending Presses by




the Steelweld Machinery Division of The Cleveland Crane & Engineering Co., Wickliffe, Ohio.

The mechanism is set in operation by depressing the foot treadle which actuates the switch and brings the torque motor into play. Only a slight pressure of the foot is required to operate the treadle since it merely closes the small switch indicated.

This mechanism reduces the fatigue of the press operator to a large extent by eliminating the usual physical effort required to engage the clutch manually. It is no longer necessary to hold the foot on the treadle to keep the clutch engaged, although such an arrangement can be provided if desirable. Other features are fast, snappy clutch and brake action with wear considerably reduced because of decreased clutch and brake slippage.

The gear segment is thereby brought to one extreme position or other depending upon whether the clutch or brake is being engaged. (The photograph shows the brake engaged.)

The machine illustrated is a Model M6-10 and is designed to bend 10 ft. of $^{3}/_{4}$-in. steel plate between the end housings or plate 12 ft. 6 in. wide by $^{5}/_{8}$-in. thick over entire length of bed and ram.

---

## OXYGEN TANK IS WELDED

For sturdy, airtight construction, an oxygen tank recently completed for the Burdett Oxygen Co. of Cleveland, Inc., was completely arc welded. Consisting of two shells—an inner shell inverted into an outer shell containing water—the tank is used for storing oxygen until such time as the gas is compressed into cylinders.

The sealing effect produced by the two shells is the same as when an inverted tumbler is set into a pan of water. The oxygen bubbles up through the water from a pipe located in the lower part of the outer shell, and is trapped in the air chamber between the surface of the water in the outer shell and the roof of the inner shell. The inner shell raises or lowers on rollers, depending on the amount of oxygen in the tank.

In preparing the roof of the inner shell for welding, the pre-cut steel plates making up the roof were laid out on truss-

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EMPIRE STATE BLDG., NEW YORK

A LARGE steel warehouse, Brown-Wales Co., Boston—busy rushing out defense orders—was up against it when a casting of a vital 4-ton plate shear suddenly let go. Many shipments were held up by the fracture—two feet across one leg and eighteen inches up the bed plate. It was out of the question to wait for a new casting.

A difficult situation to be sure, but the Industrial Welding Company of South Boston, Mass., saved the day by welding the fracture with Tobin Bronze. Using 126 pounds of Tobin Bronze Rod, 1500 feet of oxygen and 800 feet of acetylene, they repaired the shear in twenty-four hours—six hours for preparation and eighteen hours of actual welding time.

Should you ever be faced with a similar emergency, bear this story in mind. It is typical of how Tobin Bronze welding has salvaged countless pieces of expensive equipment, seemingly damaged beyond repair. And remember, too, not only does Tobin Bronze make strong, sound welds, but because of its low melting point, its use effects large savings in pre-heating time and fuel consumption. The trademark "Tobin Bronze Reg. U. S. Pat. Off." is stamped on every Tobin Rod. Look for it and be sure you get the genuine.

41186-A

ANACONDA
from mine to consumer

**Anaconda Welding Rods**

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

*In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* • *Subsidiary of Anaconda Copper Mining Company*

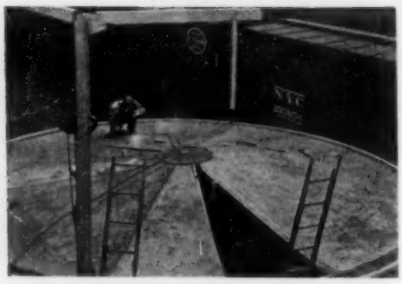

*Photo courtesy General Electric Company*

work for support and tack welded at several points.

After all the seams of the two shells were welded, making the tank airtight, the rollers which serve as guides when the inner shell is raised or lowered were welded to the top of the outer shell, at the I-beam positions.

The outer shell of the tank is 25 ft. in diameter, 8 ft. 6 in. high, and is fabricated from 1/4-in. steel plate. The side and bottom of this shell were butt welded; 2-in. reinforcing strips were welded under the bottom joints. The inner shell is 24 ft. in diameter, approximately the same height as the outer shell, and is fabricated from 1/8-in. steel plates.

## PORTABLE OVERPASS

There is a legal way to go through red traffic lights. That's the Tournapass demonstrated recently at busy Peachtree and Wesley Roads, Atlanta, Ga. This completely arc-welded steel portable overpass allows a constant flow of through traffic at busy intersections.

This streamlined overpass is an all-steel, all-welded structure made of three 60-ft. alloy steel spans, a center arc span and two end spans. Each span was welded into a solid one-piece unit. The end spans are hinged to the center span for portability as well as for setting up on different street elevations.

The structure has great strength, yet it is very light in weight. These factors are due to its welded box beam construc-

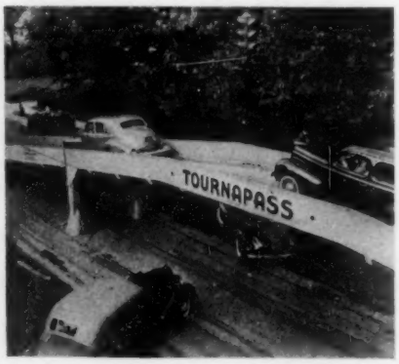


*Photo courtesy Hobart Brothers Co.*

tion. The box beam side girders—the box beam floor joists and the solid steel floor plate all welded, in each span, into a rigid one-piece unit—resist torsion and twisting strains throughout the entire span. The box beam floor joists, welded into and being an integral part of the box beam side girders, allow for cantilever loading as well as straight loading of the Tournapass floor.

The Tournapass is designed to fit into traffic lane: outside width of 10 ft., inside usable width of 8 ft. It can be used singly or in pairs and series depending on traffic conditions. The solidity of its welded construction makes it practically noiseless.

Speedy arc-welded construction kept the cost of the Tournapass at $5200. Overpass was constructed in the experimental department of the Le Tourneau Co. of Georgia under the supervision of Jack Salvador, General Manager.

## 83-MILE DEFENSE PIPE LINE

A new 83-mile, 10 3/4-in. National Defense pipe line to relieve the Pacific Coast tanker shortage by transporting oil from Ventura to Wilmington (Los Angeles), Calif., for production of vitally needed high-test aviation gasoline was just recently completed in the record time of 30 days by use of arc-welded construction.

Built for the Shell Oil Company by the Macco Robertson Construction Company of Clearwater at a cost of $2,000,000, the line was "stove-piped," every joint being individually arc welded. Joints were welded in three beads by the shielded-arc process.

There were 435,000 ft. of pipe weighing 9000 tons. An average of 12,500 ft. of


*The Chief Inspector Says*

**"Rejects have been reduced to a minimum since we equipped our machines with Mallory Standardized Welding Tips."**

There's no better place to check the efficiency of any factor in fabrication than the inspection line. It is here that Mallory's program of welding electrode standardization again proves its worth.

Standardization has provided unlimited field experience on which to base sound improvements in cooling, in hardness, in design, in electrical and thermal conductivity for each resistance welding purpose. The result is better, faster welding . . . with less "down time" for redressing . . . and a far greater total number of welds before replacement is necessary. Standardization has also eliminated costly delays waiting for special electrodes to be completed.

If you are joining similar or dissimilar metals, be sure to take advantage of Mallory's investment in better welding by making Mallory Welding Electrodes your standard specification.

MALLORY
Resistance Welding Data Book

Don't be without this invaluable source of comprehensive technical information on all phases of resistance welding, alloys and specifications. Write for your copy today.

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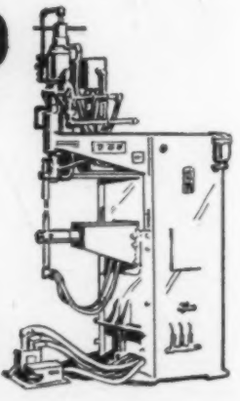
# SPEED-UP SPOT WELDING



**NEW Oakite cleaning process for aluminum helps you get MORE welds in less time!**

If you are spot welding aluminum alloy structures or assemblies, you can easily SPEED-UP PRODUCTION by using a newly developed and APPROVED Oakite process that successfully and SAFELY prepares metal surfaces for this operation. Let specially designed Oakite cleaning materials help you in preparing metal parts of all types for any welding operation. Interesting data gladly mailed FREE to those requesting it on their business letterhead.

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# Sections—CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

**BIRMINGHAM** 3rd Fri.
CHAIRMAN—F. E. McATEE, Chicago Bridge & Iron Co., 1564 No. 50th St., Birmingham, Ala.
SECRETARY-TREAS.—W. L. POOLE, Air Reduction Sales Company, 2825 No. 29th Ave., Birmingham, Ala.

**BOSTON** 2nd Mon.
CHAIRMAN—P. L. P. FEYLING, Whitehead Metal Products Co., Inc., Cambridge, Mass.
SECRETARY—P. N. RUGG, 22 Eastern Ave., Wakefield, Mass.

**CANAL ZONE** 1st Tues.
CHAIRMAN—R. E. HOLLICK, Box 1146, Ancon, Canal Zone
SECRETARY-TREAS.—JAMES G. MURRAY, P. O. Box 623, Diablo Hts., Canal Zone

**CHATTANOOGA, TENN.** 1st Wed.
CHAIRMAN—R. B. BAYSTON, Chattanooga Boiler & Tank Co., Box 110, Chattanooga, Tenn.
SECRETARY—M. R. McLAIN Combustion Engrg. Co., Chattanooga, Tenn.

**CHICAGO** 3rd Fri.
CHAIRMAN—A. M. UNGER, Pullman-Standard Car Mfg. Co., Chicago, Ill.
SECRETARY—M. S. HENDRICKS, Welding Engineer, Room 731, 506 South Wabash Avenue

**CINCINNATI, OHIO**
CHAIRMAN—WM. A. MADDUX Cincinnati Milling Machine Co., Cincinnati, Ohio
SECRETARY—R. L. KIRBY, Hobart Bros. Co., Troy, Ohio

**CLEVELAND** 2nd Wed.
CHAIRMAN—J. F. MAINE, Republic Structural Iron Works, Cleveland, Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corporation, Cleveland, Ohio

**COLORADO** 3rd Wed.
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.
SECRETARY-TREAS.—H. W. CREAGER, Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

**COLUMBUS, OHIO** 2nd Fri.
CHAIRMAN—F. B. DAHLE, Battelle Memorial Institute, Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

**CONNECTICUT** 1st Tues.
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SECRETARY—E. S. ELWOOD, JR., General Electric Co., 1285 Boston Ave., Bridgeport, Conn.

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SECRETARY—G. N. SIEGER, S. M. S. Corp., 1165 Harper Ave., Detroit, Mich.

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CHAIRMAN—RALEIGH DRENNON, 357 W. Peachtree St. N. E., Atlanta, Ga.
SECRETARY—EDWARD GUILLOTT, 282 Spring St. N. W., Atlanta, Ga.

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SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H.

**INDIANA**
CHAIRMAN—WAYNE H. MCGLADE, J. D. Adams Mfg. Co., Indianapolis, Ind.
SECRETARY—E. M. LEWIS, Allied Weld-Craft, Inc., 401 West South St., Indianapolis, Ind.

**KANSAS CITY, MO.** 3rd Mon.
CHAIRMAN—L. R. ST. JOHN, Kansas City Highway Comm., Court House, Kansas City, Kan.
SECRETARY—CARL PETERSON, Welding Equipment Supply Co., 1617 Walnut St., Kansas City, Mo.

**LAKE SHORE**
CHAIRMAN—A. W. WIEMANN, Armour Leather Co. Sheboygan, Wis.
SECRETARY—R. E. KING, 1308-A Hamilton St., Manitowoc, Wis.

**LOS ANGELES** 3rd Thurs.
CHAIRMAN—J. C. GOWING, Hobart Brothers Co., 1708 So. Soto St., Los Angeles, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equipment Co., Los Angeles, Calif.

**LOUISIANA** 1st Fri.
New officers not yet selected.

**MARYLAND** 3rd Fri. except April
CHAIRMAN—R. A. MANSFIELD, Southern Oxygen Co., Baltimore, Md.
SECRETARY-TREAS.—ARTHUR WYNN, 13 No. Hill Road, Baltimore, Md.

**MILWAUKEE** 3rd. Fri.
CHAIRMAN—J. J. CHYLE, A. O. Smith Corp., Milwaukee, Wis.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

**NEW YORK** 2nd Tues. except when Joint Meeting is held
CHAIRMAN—E. V. DAVID, Air Reduction Sales Co., 60 E. 42nd St., N. Y. C.
SECRETARY—GEORGE SYKES, Union Carbide Co., 30 E. 42nd St., N. Y. C.

**NORTHWEST** 3rd Wed.
CHAIRMAN—J. H. BARRON, Stainless Steel Prod. Co., St. Paul, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis, Minn.

**NORTHERN NEW JERSEY**
CHAIRMAN—F. C. FYKE, Standard Oil Development Co., Elizabeth, N. J.
SECRETARY—H. S. CARD, 449 Elmora Ave., Elizabeth, N. J.

**NORTHERN N. Y.** Last Thurs.
CHAIRMAN—E. F. POTTER, 30 Hazelwood Terrace, Pittsfield, Mass.
SECRETARY—W. W. CHURCHILL, General Electric Co., Schenectady, N. Y.

**OKLAHOMA CITY** 1st Thurs.
CHAIRMAN—C. C. WILLIS, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
SECRETARY—WM. T. TIFFIN, University of Oklahoma, Norman, Okla.

**PEORIA—CENTRAL ILLINOIS**
CHAIRMAN—WALTER J. BROOKING, R. G. Le Tourneau, Inc., Peoria, Ill.

**PHILADELPHIA** 3rd Mon.
CHAIRMAN—A. J. RAYNO, Baldwin Locomotive Wks., Philadelphia, Pa.
SECRETARY—K. W. OSTROM, Arcos Corp., 401 N. Broad St., Phila., Pa.

**PITTSBURGH** Middle Wed.
CHAIRMAN—A. E. MARBLE, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros., 1201 House Bldg., Pittsburgh

**PUGET SOUND**
CHAIRMAN—FRANK BOLTE, 1712 Summit Ave., Seattle, Wash.
SECRETARY-TREAS.—JOHN NELSON, Air Reduction Sales Co., 3623 E. Marginal Way, Seattle, Wash.

**QUAD CITIES**
CHAIRMAN—A. R. GUSTAFSON, 840 Third Ave., Moline, Illinois
SECRETARY—J. W. SHUGARS, Lincoln Elec. Co., Moline, Illinois

**ROCHESTER, N. Y.** 1st Thurs.
CHAIRMAN—WM. CONLEY, Univ. of Rochester, River Campus, Rochester, N. Y.
SECRETARY—PAUL W. JAMES, Lincoln Electric Co., 65 Lancaster St., Rochester, N. Y.

**SAN FRANCISCO** Last Fri.
CHAIRMAN—H. CHANEY, Bethlehem Steel Co., San Francisco, Calif.
SECRETARY—J. G. BOLLINGER, Air Reduction Sales, Park & Halleck Sts., Emeryville, Calif.

**ST. LOUIS** 2nd Fri.
CHAIRMAN—H. H. SHEAFF, Combustion Eng. Co., Heine Boiler Div., St. Louis, Mo.
SECRETARY—M. J. LETICH, Combustion Engrg. Co., Heine Boiler Div., St. Louis, Mo.

**SOUTH TEXAS**
CHAIRMAN—G. W. WOODS, Hughes Tool Co., Houston, Texas
SECRETARY—W. H. GREER, Box 175, Houston, Texas

**TULSA, OKLAHOMA**
CHAIRMAN—F. A. HOFFMAN, Tulsa Boiler & Mach. Co., Tulsa, Okla.
SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

**WASHINGTON, D. C.** 2nd Tues.
CHAIRMAN—B. B. SWOPE, Southern Oxygen Co., Arlington, Va.
SECRETARY—E. BROOKER, 129 South Buchanan St., Arlington, Va.

**WESTERN NEW YORK** Last Mon.
CHAIRMAN—G. M TREFTS, III, Farrar & Trefts, Inc., Buffalo, N. Y.
SECRETARY—D. W. PATTERSON, Federal Mach. & Welder Co., Buffalo, N. Y.

**WICHITA, KANSAS**
CHAIRMAN—W. H. GRIFFITH, % Cardwell Mfg. Co., 801 So. Wichita St., Wichita, Kans.
SECRETARY-TREAS.—K. O. HOUSER, Kansas Gas & Electric Co., Wichita, Kansas

**YORK—CENTRAL PENNA.**
CHAIRMAN—W. B. LAIR, 1109 So. Queen St., York, Pa.
SECRETARY—C. E. LEWIS KERCHNER, 290 W. Cottage Pl., York, Pa

**YOUNGSTOWN (OHIO)** 2nd Mon.
CHAIRMAN—ROBERT E. HAAS, P. O. Box 1350, Warren, Ohio
SECRETARY-TREAS.—E. J. DEL VECCHIO, Taylor-Winfield Corp., Warren, Ohio

*Photo courtesy Lincoln Electric Co.*

pipe were laid daily, indicating the speed possible with welded construction.

Extreme hilly terrain—the line is through the Santa Monica mountains at an elevation varying between 950 ft. and 1700 ft.—required bending the pipes over hills, around bends and into valleys. Slopes of 60° were not unusual. Bending was done with the pipe cold, but in many instances with the weld still warm, attesting the strength of the welded joint.

The new line will deliver 22,000 barrels of oil daily to the Wilmington refinery of Shell Oil Company and increases the company's expenditures in California pipe lines to $12,000,000.

## TRUCK BODIES ARC WELDED

Truck bodies built to withstand shock and abuse under all conditions are being turned out for use in the war zones of Great Britain by the Perfection Steel Body Company, Galion, Ohio. The bodies are completely arc welded for minimum weight, smooth appearance and the necessary durability.

Prior to the use of arc welding, riveting was used in the fabrication of the truck bodies. The excessive weight of the finished product, high costs of rivet-heating and hole-punching, and retarded production accompanying this method of fabrication, however, led to the adoption of arc welding. The result was a reduction in over-all production costs of 30%, savings in production time of 40%, and increased sales of 50%.

Welders are ceiling-mounted, leaving floor space for production work; the latter eliminates arc pop-outs.

*Photo courtesy General Electric Co.*

## IMPORTANCE OF ARC WELDING SYMBOLIZED BY NEW STAMP

The tremendous part arc welding is playing in the war effort of the Union of South Africa has been recognized by the issuance of a special postage stamp. This indicates that the Union is not lagging behind other countries in the use of this new industrial giant in the construction of her ships, tanks, aircraft and similar equipment.

The photographs, supplied by The Lincoln Electric Company, Cleveland, Ohio, shows two of the stamps which are of 6*d*. value. Each stamp is printed both in English, as shown on the right, or Afrikaans, as on the left. This is the case with all stamps issued in South Africa.

The stamp depicts a welder using modern shielded electric arc equipment and dressed in protective head shield, gloves and other special clothing.

*Photo courtesy Hobart Bros. Co.*

## WELDED GUITAR

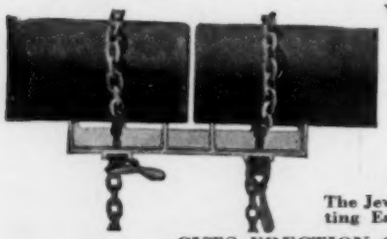
And now it's an all-welded guitar. Constructed in only a few hours' time by arc welding, this unique instrument is reported to have remarkable tonal qualities. Guitar box is made of 20 gage aluminum; keyboard from aluminum scrap and pipe; frets were pressed into required number of holes in keyboard and calked. Entire musical instrument was constructed by arc welding using $^1/_8$-in. Hobalum—a specially coated, reverse polarity, aluminum rod for welding aluminum sheets. The guitar, the craftsmanship of Victor D. Thomas of Kent, Ohio, was built before the present defense shortage on aluminum.

## WELDING GLASS

To help meet the extremely heavy demand for eye protection among welders and cutters—a demand resulting from National Defense requirements—the American Optical Company of Southbridge, Mass., has inaugurated large-scale production of a welding plate called Filterweld—a scientific absorption glass which protects eyes against glare and invisible radiation.

Filterweld absorbs ultra-violet and infra-red, has fixed standards of densities and conforms to U. S. Bureau of Standards specifications.

**PIPE WELDING TOOLS THAT MAKE WELDING PAY**



**Pipe Clamps**
**Flange Clamps**
**Elbow Clamps**
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**Pipe Markers**

TWO SIZES
½ to 8 in. 8 to 16 in.
Light—Adjustable—Fast

**The Jewel System of Pipe and Fitting Erection Ready for the Weld**

**CUTS ERECTION COSTS**

**Keeps the Welder Welding Instead of Waiting**

**JEWEL MANUFACTURING COMPANY**
**1841 University Ave., St. Paul, Minn.**

***SAVE MONEY . . . BY WELDING***

**Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers**
**with**

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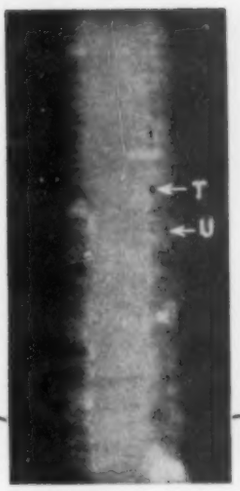
Reg. U. S. Pat. Office. U. S. Patents 1,876,738—1,947,167—2,021,945
*11 to 13% Manganese Nickel Steel*
**WELDING ELECTRODES, WEDGE and APPLICATOR BARS, HOT ROLLED PLATES**

**STULZ-SICKELS CO.** *Sole Producers* 134-142 Lafayette St., Newark, N. J.
*Sold Through Distributors Only*

# How X-Ray Gives "INSIDE" Story On Welds!




## ACCEPTABLE

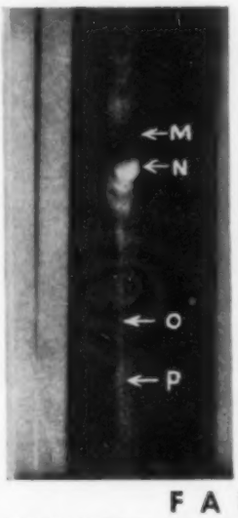
This illustrates a completely satisfactory weld of unusual width. Thickness of welded metal neither too great nor too small and bears proper relationship to adjoining plate as shown by relative density of shadows. Excellent penetration and complete fusion, with flowing at walls of joint producing smooth edge with characteristic waves. Slight porosity at "t" and "u" due to entrapped slag or gas bubbles, but dimensions are small and weld is fully acceptable.

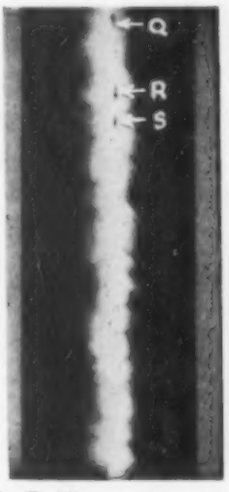
THESE three illustrations are all prints of radiographs produced by KELEKET X-ray equipment. They show how easy it is to determine the quality of welds through this modern inspection method.

Flaws can be detected before expensive fabrication or machining has been done. This saves time, money, and improves quality. Development work can be checked by X-ray until a welding technique is perfected. Then radiographs can be produced to keep pace with a fast assembly line.

The selection of KELEKET units by many leading industrial concerns is due to our recognized position in the field of X-ray. For forty-one years KELEKET has specialized in X-ray apparatus. As a result, KELEKET meets the requirements of industry and offers the type of equipment best suited to each individual need. Mail coupon for specific information.

**THE KELLEY-KOETT MFG. CO., COVINGTON, KY.**
*Representatives in 64 Cities*




## FAULTY

This illustrates an unsatisfactory weld. Grayish appearance indicates insufficient welding metal. Smooth edges show lack of penetration into walls of joint. Blowhole at "m" caused piling of excess metal at "n". Welding metal piled against walls of joint in straight line from "o" to "p" with practically no fusion.

This illustrates another unsatisfactory weld although surface appearance was excellent. White shadow indicates excess of welding metal. Hazy, irregular edges show lack of penetration into walls of joint and incomplete fusion. Arrows point to entrapped slag, indicated by dark spots on film, producing flaws of dangerous size.

KELEKET X-RAY

# INDUSTRIAL EQUIPMENT

The Kelley-Koett Mfg. Co.
218-1 West Fourth Street
Covington, Ky.

• Without obligation, please advise how KELEKET equipment can be used profitably in this plant for inspection of _____

Name _____ Title _____

Firm Name _____

Address _____ State _____

City _____

PIONEER CREATORS OF *QUALITY X-RAY* EQUIPMENT SINCE 1900

# NEW PRODUCTS

**The Society assumes no responsibility for the validity of claims in this Section**

### NEW TEMPILSTIK

The Tempil Corp., 132 West 22nd Street, New York City . . . makers of Tempil° Thermometric pellets . . . announce a new, convenient form of their product, called Tempilstik°.

Tempilstiks°, like Tempil° pellets, have a specified melting point. They are available from 125° F. to 1600° F., in convenient temperature intervals, and have a mean accuracy of within 1% of the temperature clearly stamped on each stick or pellet.

Thus a 300 Tempilstik°, drawn across a surface heated to less than 300° F., will leave a chalklike mark . . . which melts sharply into a liquid streak when the surface reaches 300° F.

The new Tempilstik° offers a means of leaving a temperature signal mark on less accessible places, such as vertical, inclined and overhead surfaces. Properly used, each stick will yield up to 1000 temperature determinations.

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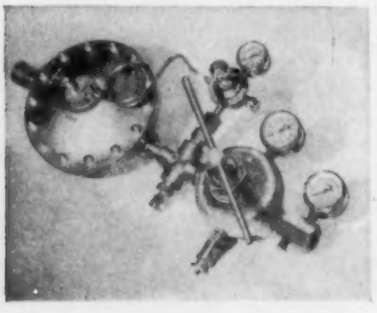
### OXYGEN REGULATOR

Victor Equipment Company of San Francisco recently designed and now manufacture an interesting new regulator unit, capable of delivering with maximum pressure accuracy over 100,000 cu. ft. of oxygen hourly.

The spring-loaded diaphragm regulator at the right of the illustration reduces primary cylinder pressure from 2000 lb. to a desirable maximum operating pressure of 250 psi. The center T connection manifolds together the primary and secondary stage Master Regulator, as well as the smaller Pilot Regulator. This Pilot Regulator controls the diaphragm loading pressure of the large diameter second stage reduction regulator, which is of the Victor patented "Gas-O-Dome" type. The Pilot Regulator prevents accidental overloading of the diaphragm and enables the operator to adjust final operating and delivery pressure accurately and safely. The entire unit is equipped with self-seating and bursting disk type relief valves at all pressure stages.



All regulator seat mechanisms are easily accessible and damaged seats may be exchanged for new ones without major disassembly.

Both inlet and outlet accommodate standard $^{3}/_{4}$-in. pipe connections usually employed in cylinder manifolds.

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### HANDY WELDER'S ACCESSORIES

These two new welder's accessories promote speed and safety. The Cover Glass Case is made of chrome leather and has snap fastener. Slits in the back for belt. Stiff fiber reinforcement protects cover glass from harm. The Electrode Carrier is furnished with a web belt and is made

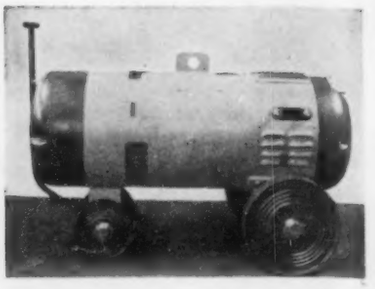
with two compartments. Saves time and trouble by allowing the welder to have extra electrodes handy at all times. Made from chrome leather, it is durable and inexpensive. Both items are manufactured by Safety Clothing & Equipment Co., 7016 Euclid Ave., Cleveland, Ohio.

---

### PORTABLE D-C WELDER

For all-purpose welding in industrial plants, shipbuilding and for general maintenance work, a new portable flexarc welder is announced by Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Attractively finished in blue and gray, the enclosure is made of a one-piece weather-proof steel frame mounted on a 4-wheel running gear. Ratings are 200, 300 or 400 amperes for 220-, 440- and 550-volt A-C circuits; 2 and 3 phase, 25, 50 and 60 cycles.

Current adjustment is obtained by a ball crank making it possible to pre-set the desired current before welding. Steady



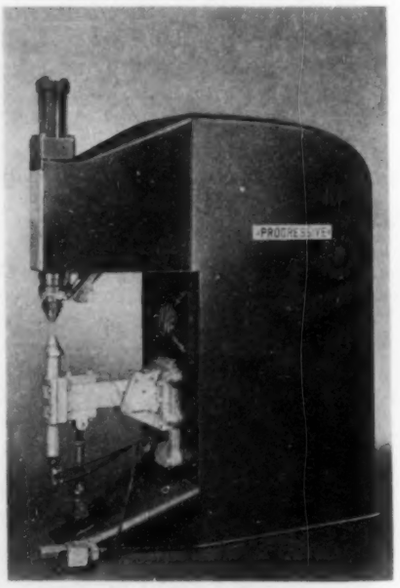
current regardless of arc length is provided by arc control which can be adjusted to suit the welding job.

In operating, a magnetic shunt is placed in the armature reaction flux path. Output current of the welding generator is adjusted by ball crank control of the position of a laminated iron leakage block. This block serves as a magnetic shunt for the reaction flux of the machine, and its position with respect to the main flux path determines the welding current. By this principle, no field rheostat exciter or external reactor is required.

---

### FORGE WELDER

A virtual doubling of available "forging" pressures, simplification of controls, incorporation of an automatic current increase control, heavier construction throughout, and attractive streamlining of the entire machine, are among the new features of a new "Forge-Welder" just announced by Progressive Welder Company, 3050 E. Outer Drive, Detroit.



With this improved forge welder it is now possible to obtain excellent welds, free of blow-holes on hot rolled sections, without the necessity of removing scale or rust prior to the welding operation.

Forging pressure has been increased to a total available of 20,000 lb. per sq. in.,

# RESEARCH DEVELOPMENTS IN RESISTANCE WELDING FOR A NEW ERA IN PRODUCTION

The present demand for greater efficiency and speed in the production of defense materials and machines, has engaged the engineering genius of our nation. Future production, obviously, will embrace improvements in design and manufacturing methods pre-induced by this emergency. Federal engineering accomplishments will eventually be utilized in the manufacture of products for the increased convenience and comfort of America.

## FEDERAL IS ON THE MARCH

*Rocker Type, Conventional or UNI-PULSE Spot Welder for welding Aluminum Alloys*

The Federal Machine and Welder Company is today cooperating 100% with the government in supplying Resistance Welding Machines to vital defense industries. New metal fabricating problems are constantly being met and solved. The field and usage of Resistance Welding is being broadened with each passing day. Research and development never end. Federal is on the march. *Send for Technical Bulletin No. 527 pertaining to Uni-Pulse Aircraft Spot Welding. Bulletin on Shell-Turning Equipment also available.*

*Rocker Press UNI-PULSE Spot Welder with Patented Low Inertia Head*

THE Federal MACHINE AND WELDER COMPANY WARREN, OHIO

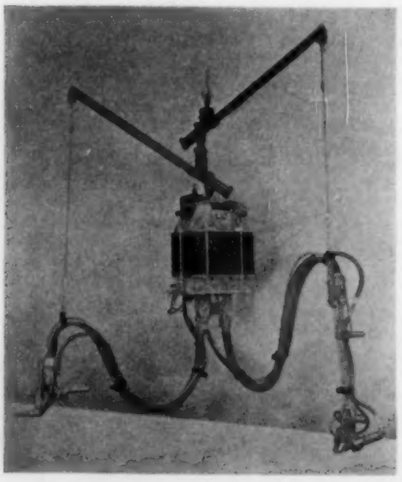
SALES OFFICES IN ALL PRINCIPAL CITIES

this pressure being superimposed on the normal electrode pressure to obtain the "forge-welding" action. The pressure is obtained through the incorporation of a motor-driven hydraulic pump unit. Both pressure and machine cycle are controlled through an improved sequence timer.

Included in the controls, which are more accessible than previously in addition to being simplified as to adjustment, are a new phase-shift heat control and a new automatic current increase control. The latter unit is provided with three dials to permit pre-selecting of the following: (1) value of initial, minimum current (for first pulsation); (2) value of final, maximum current; (3) rate of increase of current (time from minimum to maximum).

## NEW ADJUSTABLE COMPOUND HANGER

A line of compound springless, adjustable balanced hangers has been introduced by Progressive Welder Company, 3050 E. Outer Drive, Detroit, Mich. Of the swiveling type, the hanger permits individual counterbalancing of two separate units, such as welding guns, riveting equipment and other forms of heavier type "hand" tools.



The new hangers are individually adjustable for weights to be counterbalanced. The hangers are available in two sizes, the No. 87DS9 for light and medium duty, and the No. 87DS10 for heavy duty. When used with welding guns, for which the hangers were originally developed, the former will support guns and transformers up to 75 kva., while the heavy duty type is designed for guns and transformers rated up to 150 kva. No special attachments are required to install the new hangers.

## NEW WELDING TIMER

Especially adapted for seam and spot welding where frequent changes of timing are necessary, a new ignitron welding timer is announced by Westinghouse Electric and Manufacturing Company.

Known as the SX, the unit consists of a control panel and ignitron tube assembly mounted in a common enclosing cabinet. The ignitrons are essentially mercury arc rectifiers with an ignitron or control electrode inside. Heat of the arc is removed by a water cooling system. Seam weld "on" or "off" timing adjustable from 1 to 30 cycle steps is provided; one to 15 pulsations can be made for each setting.

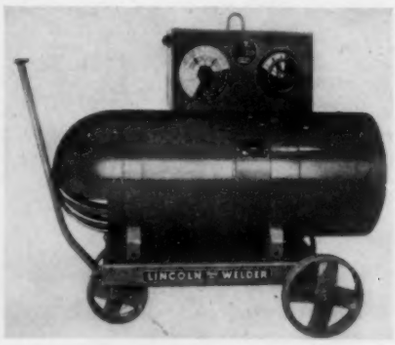
In operating, the electronic tubes and circuits perform five distinct functions: (1) "on" timing; (2) "off" timing; (3) pulsation counting; (4) heat control; (5) firing of the ignitron power tube.

When the weld initiating switch is closed, a relay closes its contacts. At a predetermined point in the voltage cycle, corresponding to the power factor of the welding machine, the start tube in the "on" timing circuit is energized, and the ignitrons begin to conduct. At the end of the "on" time interval, the stop tube in that circuit becomes energized, and simultaneously the start tube in the "off" timing circuit is energized. At the end of the "off" time interval the whole sequence is repeated.

## IMPROVED WELDER CONTROL

Improved and simplified design of its exclusive system of "Dual Continuous Control" for arc welding machines which eliminates the need for meters showing volts and amperes is announced by The Lincoln Electric Company, Cleveland, Ohio.

This new welding facility has been in engineering design development and preliminary production line-up for some time and is said to be achieved as a result of the accuracy possible in current adjustments with "Dual Continuous Control" in conjunction with Lincoln's self-indicating pre-set dials.




These welders have both job selector and current control calibrated and equipped with dials which indicate the type of work and the number of amperes for each and every setting. It is claimed that this feature enables the welding operator to secure highest quality welds and highest possible welding speeds because he can vary both the slope of the volt-ampere curve and the amount of welding current independently and positively to suit every job encountered

Another feature of this welder control is that both voltage control (job selector) and current control are continuous in operation. This design provides literally thousands of possible combinations of voltage and current.

## EXCESS UNION MELT FLUX RECOVERED

Among the many operations in the program of the Todd-California Shipbuilding Corp. there is welding and the important recovery of excess flux behind the Union Melt welding machine. For the reclaiming of such valuable material they use a powerful industrial vacuum cleaner, by name, the Tornado, a product of the Breuer Electric Mfg. Co., Chicago.

At the time it is regained the flux is at a high temperature, yet is recovered without damage to the cleaner, and replacements are kept at a minimum. Almost all of the excess flux is salvaged, which results in a considerable saving of this material.

**View of Todd-California Shipbuilding Corp. Plant, Showing Tornado Industrial Cleaner Recovering Excess Flux in the Wake of the Linde Welding System in Use**

## WELDING TERMINAL PANEL

A Welding Terminal Panel has been developed by O. Z. Electrical Mfg. Co., Brooklyn, N. Y., particularly for use in shipyards and similar installations in connection with the Constant Potential System of Welding Feeders. The new device provides opportunities to install at any desired points panels that intercept the main welding feeders throughout the yard, and provide facilities for the welding leads.

Panels (*1*) are a solid bronze casting mounted on an ebony asbestos block (*2*) which in turn is mounted in No. 10 gage

# *There's the* STAINLESS STEEL WELDING ELECTRODE YOU WANT"

• It's listed on page 6 of this booklet on Stainless Steel Welding and Electrodes that has been prepared by PAGE.

•

You probably know as well as we do that you must look for and insist on getting two distinctly different *kinds* of quality in your Stainless Steel Electrodes.

It is imperative for good Stainless Steel Welding that the deposit *in the weld* be equal to the Stainless Steel you are welding.

It is just as important that the electrode be of the shield-arc type, to protect the metal in the weld; equally usable in horizontal, vertical and overhead positions; permit high speed welding with minimum spatter and slag loss and smooth beads.

To get all those qualities for you, PAGE worked in the field and laboratory with the world's largest producers of Stainless Steel —until they said every PAGE Stainless Electrode was *right*.

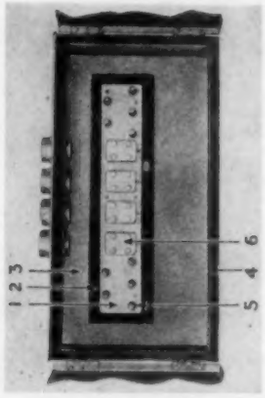
Start right, then, with your Stainless welding. Depend on PAGE. Tell your local PAGE Distributor the Stainless Steel you want to weld and accept his recommendation.

**Be sure to ask your local PAGE Distributor for a copy of this valuable, well illustrated booklet on the welding of Stainless Steels. It covers the entire subject.**

## PAGE WELDING ELECTRODES

PAGE STEEL AND WIRE DIVISION • MONESSEN, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc. BRIDGEPORT, CONNECTICUT




bent-up construction iron box (*3*), completely hot dipped galvanized after fabrication. The box top is slanted to shed water. Slots (*4*) in the bottom of the box provide entry for welding leads which are to be attached to terminal studs (*5*) on the panel. These stud bolts are force-fitted through the back of the casting. The removable plates (*6*) or clamps provide means for tapping the main feeder.

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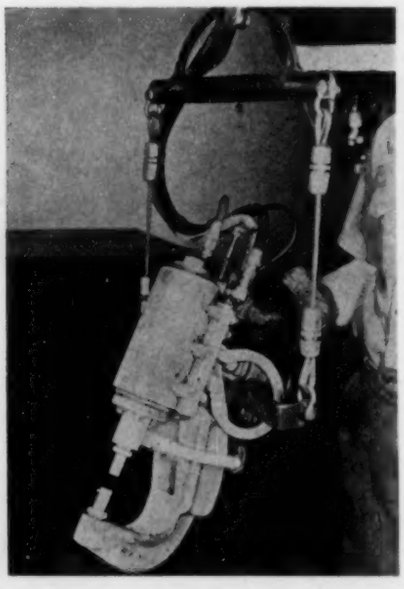
## WELDING GUN FOR ALUMINUM

As the result of demand from the aircraft industry for portable resistance spot welding equipment for tack welding and assembly welding of sections in fixtures, where the work cannot be taken to stationary pedestal welders, Progressive Welder Company, 3050 E. Outer Drive, Detroit, has developed a portable welding gun specifically designed for resistance spot welding of aluminum.



The gun—with its transformer—may be used in combination with virtually any control equipment used for welding of aluminum.

In order to facilitate production of various shapes of guns to fit specific manufacturing requirements, the new Progressive gun has all its operating mechanism built into a gun "head," which may be supplied with yokes to fit individual needs.

The new gun is air operated, employing two differential cylinders in tandem, designed to produce a maximum point pressure of 1200 lb., when using normal factory airline pressure.

For structural spot-welding of aluminum, the gun will handle up to two pieces of 0.040 in. thickness. For tack welding, greater thicknesses may be handled.

Incorporated in the gun head is a manually controlled point retracting mechanism, which permits retraction of one electrode to permit clearing of obstructions. The gun has a maximum stroke of four inches. The new gun is designed for the application of refrigeration to the welding tips.

Refrigerating units recently developed for this purpose by Progressive Welder Company are effective in multiplying by several times the number of welds which can be made before the points need redressing, reducing both tendency toward pick-up and mushrooming.

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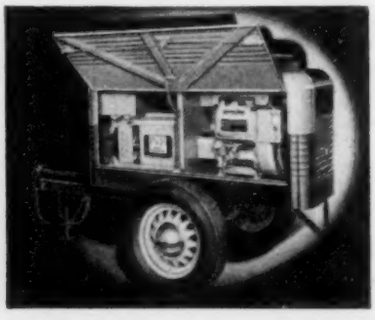
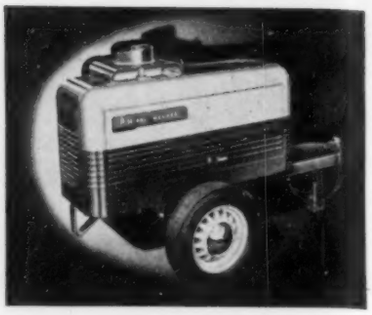
## ENGINE DRIVEN WELDERS

The Harnischfeger Corporation of Milwaukee has just introduced two new P & H-Hansen gas-driven welder units, Model WN-150 and WN-200, with capacities of 15 to 200 amp. and 30 to 260 amp., respectively. Equipped with the latest type P & H-Hansen self-contained welding generators they are powered by a direct connected heavy-duty 4-cycle, 4-cylinder,



V-type Wisconsin gasoline engine. These units are mounted on pneumatic-tired trailers with low centers of gravity which permit towing at normal traffic speeds. The wide welding ranges, single current positive power controls and mobility of these units suit them ideally for portable use.

Modern and good looking, these welders are sturdily and compactly built for lasting service. Hinged side panels allow ready access to generator and engine. When desired, the panels may be swung up and locked in place like automobile truck doors. Under the canopy recessed compartments provide ample room for storage of cables, operators tools, welding rod, etc. Locks on these panels protect the entire equipment from theft and vandalism.



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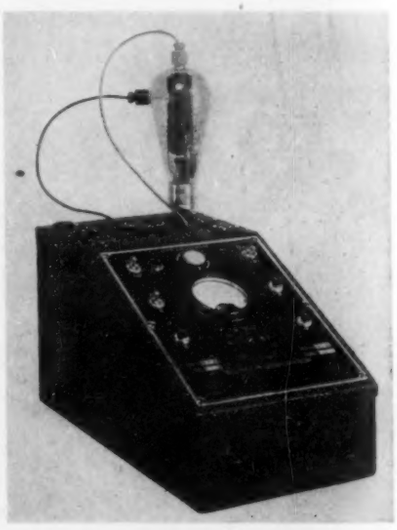
## CHECKER FOR ELECTRONIC TUBES

A Universal self-contained tube checker for industrial type electronic tubes has been announced by Weltronic Corporation, 3080 E. Outer Drive, Detroit. Provided with seven sockets, it may be used to check virtually every well-known make and type of industrial tube (except ignitrons). Special tubes may be checked through the use of socket adaptors.

The checker provides, through a one-inch cathode ray tube, a visual analysis of plate current, while high vacuum tubes can also be checked with the milliammeter provided.



On some of the more common types of tubes, the checker will provide the following information:

Thyratrons: Wave form, break-down point in cycle, and grid control.

Mercury Rectifiers: Current wave form and plate current (on meter).

High Vacuum Rectifiers: Current wave form, and plate current.

High Vacuum Control Tubes: Wave form, plate current and grid control.

Full Wave Rectifiers (2-plate): Wave form and plate current on each half, individually.

The instrument, which is housed in a substantial black crackle-finish box with sloping control board, is provided with adjustments for intensity, horizontal and vertical amplitude and focus for the oscilloscope. It operates on 110 to 120 v., 60-cycle current. A 6-ft. cord is provided.

### WELDING TORCH

To specifically serve aviation, the Alexander Milburn Company announces the release of their new type MM Welding Torch. It is lightweight, easy to operate and has an accurately controlled flame that is adaptable for intricate work, yet hot enough to permit its use as a heating torch.

The type MM torch is designed to give best results on thicknesses of 1/8 in. and less up to 1/2 in. It is particularly useful with stainless steel and similar alloys requiring exact heat and flame control. Because of its balanced design, it is extremely useful in working around the awkward shapes ofttimes confronted in airplane construction.

The MM torch can be used as an adjunct to the lighter, smaller aviation torch, by using the MM torch to heat the area, and the small torch to weld.

For further details, write the Alexander Milburn Company, 1493 W. Baltimore St., Baltimore, Md

### YEARBOOK OMISSION

By letter ballot vote, the Directors elected Mr. A. C. Weigel, Combustion Engineering Company, Inc., 200 Madison Ave., New York to fill the unexpired term of Col. Jenks—term expiring October 1942. Mr. Weigel's name was omitted from the Year Book.

Year Book listing incorrectly spelled the name of Charles H. Trott, 1354 Monroe Street, N.W., Washington, D.C.

# List of New Members

November 1 to November 30, 1941

### BOSTON

**Jones, Frank** (C), Worthington Pump & Machinery Corp., Gun Mount. Div., Holyoke, Mass.
**Miller, Robert Scott** (C), 4 Webber St., Malden, Mass.
**Ober, Walter** (D), 991 Eastern Ave., Malden, Mass.
**Puffer, Daniel W.** (D), 9 Hatch Rd., W. Medford, Mass.
**Rowsey, Charles A.** (D), 34 Worcester St., Belmont, Mass.

### CHICAGO

**Bretto, Sam J.** (D), R. F. D. 1, Coal City, Ill.
**O'Donnell, Edward R.** (D), 2106—51st Ct., Cicero, Ill.
**Tucker, R. E.** (B), Hemphill Schools, 515 South Western Ave., Chicago, Ill.
**Walter, George F.** (C), 108 S. Lotus Ave., Chicago, Ill.

### CINCINNATI

**Altherr, W. J.** (D), 5 Tuxedo Pl., Walnut Hills, Cincinnati, Ohio.
**Archiable, John M.** (C), Emery Industries, Inc., June & Long Sts., St. Bernard, Ohio.
**Fulton, Paul** (C), Route 1, West Milton, Ohio.
**Menke, O. H.** (B), 321 W. Franklin St., Troy, Ohio.
**Nussbaum, Charles** (C), Davis Welding & Mfg. Co., 1110 Richmond St., Cincinnati, Ohio.
**Schwartz, Erum** (C), Davis Welding & Mfg. Co., 1110 Richmond St., Cincinnati, Ohio.
**Staubitz, Wm.** (B), Wm. Staubitz Sheet Metal Wks., 905 Depot St., Cincinnati, Ohio.
**Uffman, Paul J.** (C), Wm. Staubitz Sheet Metal Wks., 905 Depot St., Cincinnati, Ohio.
**Williams, Charles** (D), The G. A. Gray Co., 3611 Woodburn Ave., Cincinnati, Ohio.

### CLEVELAND

**Edgar, Donald** (C), Una Welding, Inc., 1615 Collamer Ave., E. Cleveland, Ohio.
**Halvorsen, H.** (B), The Boom Boiler & Welding Co., 2514 Center St., Cleveland, Ohio.
**Klug, Harold H.** (C), American Steel & Wire Co., Rockefeller Bldg., Eng. Dept., Cleveland, Ohio.
**Medsker, Charles A.** (C), 3278 Meadowbrook Blvd., Cleveland Hgts., Ohio.
**Mueller, Robert E.** (C), 1778 Rosedale Ave., E. Cleveland, Ohio.
**Rutkowski, Kelly** (C), Howard Welding Co., 7001 Polonia Ave., Cleveland, Ohio.
**Webber, E. A.** (C), Lake Shore Country Club, Bratenahl, Ohio.
**Wilkinson, W. W.** (C), 1519 Wood Rd., Cleveland Hgts., Ohio.

### COLORADO

**Blinkley, Wm. D.** (D), 3765 S. Acoma St., Englewood, Colo.

### CONNECTICUT

**Appon, Michael I.** (C), 60 Cedar St., New Britain, Conn.
**Eaton, George A.** (D), 12 Derby Ave., Cedar Beach, Milford, Conn.
**Hay, John J., Jr.** (D), 119 Lewis St., Bridgeport, Conn.
**McCarthy, Erwin H.** (D), 437 Kerema Ave., Devon, Conn.

### DETROIT

**Bassine, L. M.** (B), Monroe Steel Castings Co., Monroe, Mich.
**Hakalow, Hazel M.** (B), General Welding Co., 2134—20th St., Detroit, Mich.
**Jones, Wm. A.** (C), 4244 Nellie St., Dearborn, Mich.
**Moore, L. R.** (D), 625 Charlotte, Detroit, Mich.
**Williams, Howard L.** (C), 956 W. Lewiston, Ferndale, Mich.

### INDIANA

**Imes, R. H.** (B), P. R. Mallory & Co., 3029 E. Washington St., Indianapolis, Ind.

### KANSAS CITY

**Bohne, Walter M.** (B), 209 W. 19th St. Terrace, Kansas City, Mo.
**Floyd, Maynard** (C), 5301 Euclid St., Kansas City, Mo.
**Peterson, Carl** (C), Welding Equip. Supply Co., 1617 Walnut St., Kansas City, Mo.

### LOS ANGELES

**Cloud, Leslie G.** (D), 254 Sinclair Ave., Glendale, Calif.

### MILWAUKEE

**Pinigis, Victor** (D), 1410—53rd St., Kenosha, Wisc.

### NEW YORK

**Clauser, Henry R.** (B), Metals & Alloys, 330 W. 42nd St., New York, N. Y.
**Feldman, Arthur** (D), 1099 Walton Ave., Bronx, N. Y.
**Flanagan, John F.** (D), 530—5th St., Brooklyn, N. Y.
**Friedmann, Robert C.** (D), 9118—108th St., Richmond Hill, N. Y.
**Gandolp, Louis M.** (D), 47-35—188th St., Flushing, N. Y.
**Gaudiosi, Frank** (D), 94-15—71st Ave., Forest Hills, N. Y.
**Greene, Edward R.** (C), Knickerbocker Welding Supply Co., 409 W. 17th St., New York, N. Y.
**Heintz, George R.** (D), 86-02 Park Lane So., Woodhaven, L. I., N. Y.
**Lefkowitz, Arnold** (B), North American Iron & Steel Co., First Ave. & 58th St., Brooklyn, N. Y.
**Malino, Alfred** (D), 1015 Gerard Ave., Bronx, N. Y.
**Miller, Daniel D.** (B), Citizens Prp. Center, 9 W. 61st St., New York, N. Y.
**Mix, Tom** (D), 602 W. 139th St., Apt. 3, New York, N. Y.
**Scala, Thomas W.** (D), 161 Maiyer St., Brooklyn, N. Y.

### NORTHERN NEW JERSEY

**Adams, Wadsworth** (D), Box 87, R. F. D., Rainbow Lakes, Boonton, N. J.

**Ash, Charles R., Jr.** (C), Chicago Bridge & Iron Co., 119 Long Ave., Elizabeth, N. J.
**Barr, Max M.** (C), 650 Palisade Ave., Jersey City, N. J.
**Casey, Thomas** (D), 598—19th St., Brooklyn, N. Y.
**Clark, Raymond L.** (D), 215 Bloomfield Ave., Bloomfield, N. J.
**Dempsey, Raymond J.** (C), 46 Exton Ave., N. Arlington, N. J.
**Garrard, James F.** (B), M. W. Kellogg Co., P. O. Box 469, Jersey City, N. J.
**Gillespie, Forrest W.** (D), R. F. D. 1 Sussex Ave., Westville, N. J.
**Hill, Harry N.** (C), John Simmons Co., 40 Edison Pl., Newark, N. J.
**Kasper, George** (D), 7822—79th Lane, Glendale, L. I., N. Y.
**La Due, George** (D), 781—2nd St., Secaucus, N. J.
**Last, Albert** (D), 65 Summit Ave., Jersey City, N. J.
**Mahoney, Philip A.** (D),% Johnsmeyer, 77 Crescent Ave., Jersey City, N. J.
**Nicholson, John E.** (D), 36 Atlantic St., Jersey City, N. J.
**Rooke, Robert M.** (C), Air Reduction Sales Co., 181 Pacific Ave., Jersey City, N. J.
**Stader, Philip A.** (D), 633 Bordentown Ave., So. Amboy, N. J.
**Wheeler, Lloyd F.** (D), 218 Marian Ave., Fanwood, N. J.

### NORTHERN NEW YORK

**Shaw, Roscoe D.** (C), General Elec. Co., Bldg. 56, Schenectady, N. Y.

### OKLAHOMA CITY

**Beall, Clyde R.** (C), Oklahoma A. & M. College, Stillwater, Okla.
**Dennis, Gene R.** (F), 305 N. Duck St., Stillwater, Okla.
**Grundish, J. P.** (D), 1418 Northwest 11th St., Oklahoma City, Okla.

### OMAHA

**Begley, Paul J.** (D), 4109 So. 27th St., Omaha, Neb.

### PEORIA

**Brown, William F.** (D), Box 33, Johnsonville, Ill.
**Douglas, E. P.** (B), Welder's Supply Co., 206 No. 1st St., Springfield, Ill.

### PHILADELPHIA

**Bergeson, Lloyd** (B), 1710 Delancy St., Philadelphia, Pa.
**Costello, Charles J.** (C), 1212 W. Erie Ave., Philadelphia, Pa.
**Davies, Albert** (B), Eric Welding Co., Burlington, N. J.
**Humphreys, W. D.** (C), 5235 Laurens St., Germantown, Pa.
**Johnson, William E., Jr.** (D), 532 Harper Ave., Drexel Hill, Pa.
**La Terza, Humbert** (D), 109 E. Wayne Terrace, Collingswood, N. J.
**Lear, Stanley** (D), 7364 Wheeler St., Philadelphia, Pa.
**Moyer, Ned S.** (D), Main Street, Hulmeville, Pa.
**Pendleton, C. R.** (C), Bryn Athyn, Pa.
**Phair, Robert S.** (C), 3311 Powelton Ave., Philadelphia, Pa.
**Roth, Claude L.** (C), Room 1406, Sun Bldg., 1608 Walnut St., Philadelphia, Pa.
**Shelton, Donald G.** (F), 209 New Broadway, Brooklawn, N. J.
**Stees, Harry W.** (D), 1938 N. 5th St., Harrisburg, Pa.
**Tate, F. S.** (C), 3550 Bleigh St., Philadelphia, Pa.
**Van den Beemt, J. H.** (C), E. G. Budd Mfg. Co., 25th & Hunting Park Ave., Philadelphia, Pa.
**Vickers, James G.** (D), 5133 Spruce St., Philadelphia, Pa
**Zehner, Reynold L.** (C), 3314 Chippendale Ave., Philadelphia, Pa.

### PITTSBURGH

**Silverblatt, Charles** (C), 3143 Ewart Dr., Pittsburgh, Pa.

### ST. LOUIS

**Ellaby, Charles H.** (B), Board of Public Service, 304 City Hall, St. Louis, Mo.

### SAN FRANCISCO

**Koven, Alex** (D), 1347 Shafter Ave., San Francisco, Calif.

### TULSA

**Bates, Howard F.** (D), 1506 E. 35th St., Tulsa, Okla.

### WESTERN NEW YORK

**Malling, Paul A.** (C), 163 Victoria Blvd., Kenmore, N. Y.
**Morrison, Isadore** (C), Morrison Steel Prods., Inc., 601 Amherst St., Buffalo, N. Y.

### YOUNGSTOWN

**Franklin, Kenneth** (D), 220 E. Ravenwood Ave., Youngstown, Ohio.

### NOT IN SECTIONS

**Daver, Rutty R.** (C), % Welding Industry Equip., 24 Elphinstone Circle, Fort Bombay, India.
**Irens, Alfred N.** (B), Bristol Aeroplane Co., Filton House, Bristol, England.
**Janovsky, F.** (B), Fabricated Steel Mfg. Co., P. O. Box 393, Germiston, South Africa.
**Laylin, Erwin** (D), The Rudy Furnace Co., Dowagiac, Mich.
**Minton, Miller C.** (C), Goodlettsville, Tenn.
**Schweratfeger, August R.** (C), 32 Grand St., So. Portland, Maine.
**Whetstone, H. R.** (C), 902 Cedarhill Ave., Dallas, Texas.

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## COMMUNICATION TO THE EDITOR

December 22, 1941

I would like to publicly extend the use of our Welding Department and Testing Laboratory to any company wanting to test prospective Welders. There will be no charge in connection for the use of our facilities.

Hoping that in this small way we may help defend our country, I am

Sincerely yours,

(Signed) Stanley Greer, *Vice-President*,
Greer Shop Training, Inc.,
2024-26 South Wabash Ave.,
Chicago, Illinois

## CALENDAR OF EVENTS

### Society and Section Meetings

(For further details see Section Activities)

FOURTH LECTURE NEW YORK SECTION LECTURE COURSE—February 3, 1942.

OKLAHOMA CITY SECTION—February 5, 1942.

DETROIT SECTION—February 6, 1942.

NEW YORK SECTION MEETING—February 10, 1942.

CLEVELAND SECTION—February 11, 1942.

NORTHWEST SECTION—February 11, 1942.

BOSTON SECTION—February 12, 1942.

ST. LOUIS SECTION—February 12, 1942.

COLUMBUS SECTION—February 13, 1942.

PHILADELPHIA SECTION—February 16, 1942.

LOS ANGELES SECTION—February 19, 1942.

DETROIT SECTION—March 2, 1942.

OKLAHOMA CITY SECTION—March 5, 1942.

BOSTON SECTION—March 6, 1942.

COLUMBUS SECTION—March 13, 1942.

ST. LOUIS SECTION—March 13, 1942.

PHILADELPHIA SECTION—March 16, 1942.

LOS ANGELES SECTION—March 19, 1942.

NORTHWEST SECTION—March 19, 1942.

### Meetings of Other Societies

ENGINEERING INSTITUTE OF CANADA. 56th annual and general professional meeting, February 5–6, 1942, Montreal, Que.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS. Annual meeting, February 9–12, 1942, New York, N. Y.

AMERICAN PHYSICAL SOCIETY. 247th meeting, February 20–21, 1942, Detroit, Mich.

SOUTHERN SAFETY CONFERENCE. February 22–24, Roosevelt Hotel, New Orleans, La.

AMERICAN SOCIETY FOR TESTING MATERIALS. Spring meeting, March 2–6, 1942, Cleveland, O.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Spring meeting, March 23–25, 1942, Houston, Tex.

# SECTION ACTIVITIES

## BOSTON

Mr. George M. Sieger, President of the S. M. S. Corporation, Detroit, Mich., was the speaker at the December 8th meeting held at the Massachusetts Institute of Technology. His subject was "Resistance Welding—Some Practical Yet Fundamental Considerations." In his usual interesting manner, he centered his talk around three factors: Current, Time and Pressure. Mr. Irving C. Brown, Sales Manager, Thomson-Gibb Electric Welding Company, served as Technical Chairman for the meeting.

The January 12th meeting will be an evening visit to Wentworth Institute, Boston.

Thirteen members from this Section were registered at the Annual Meeting in Philadelphia. The Section was well represented at the Section Officers' meeting held at that time.

The following is the program for coming meetings:

February 12th—Joint Meeting with Boston Section of the American Society of Mechanical Engineers at Massachusetts Institute of Technology. Mr. Roy W. Emerson, Metallurgical Engineer of the Pittsburgh Piping and Equipment Co., will talk on "High Pressure Piping" including a discussion of the welding problems.

March 6th—Joint Meeting with Boston Chapter of the American Society for Metals. Place of meeting and speaker to be announced.

April—Second New England Welding Conference to be held at the Massachusetts Institute of Technology. Program to be announced.

## CHICAGO

Mr. R. D. Thomas, President, Arcos Corporation, addressed the November 21st meeting of the Chicago Section on the subject, "Welding of Stainless Steels and Air Hardening Alloys." This was an illustrated talk on the welding of stainless and other alloy steels, several of which are being used extensively in both defense and non-defense items.

## CHATTANOOGA

Mr. E. A. Mallett, of Taylor-Winfield Corporation, spoke before the Chattanooga Section on September 8th on the subject of "Resistance Welding."

Mr. E. W. P. Smith, of the Lincoln Electric Company, was, the speaker at the October 10th meeting. His subject was "Arc Welding Speeds National Defense."

"Ladies' Night" was held on November 19th. About sixty were present at the dinner and meeting. Dr. Frank W. Prescott, Professor of Political Science, University of Chattanooga, spoke on "Repeal of the Neutrality Act." An enjoyable sound movie was also presented.

## CLEVELAND

T. R. Lichtenwalter, metallurgical engineer for the Republic Steel Corp., addressed the Cleveland Section on December 10th at the Cleveland Engineering Society. His subject was "Metallurgical and Welding Characteristics of Stainless Steel Alloys." The talk was followed by a movie entitled "Enduro" and a question period.

A "Coffee Talk" also was presented by Dewey Mitchell, physical director of the Cleveland Police Academy. Mitchell, who is responsible for the health program of the police and fire departments of the city, personally directs the instruction of special courses such as wrestling, jujitsu and calesthenics. Much of his talk concerned tricks of the oriental art.

## COLUMBUS

The regular monthly meeting of the Columbus Section was held on December 12th. A turkey dinner preceded the meeting. Mr. A. N. Kugler, of the Air Reduction Sales Co., gave a discussion on "Oxyacetylene and Electric Welding."

Feb. 13th—Dinner Meeting—Hotel Fort Hayes. "Welding Nickel Alloys," by F. G. Flocke, International Nickel Co.

March 13th—Meeting—Battelle Memorial Institute. Moving Pictures (Materials), General Motors Corporation.

April 10th—Dinner Meeting—Hotel Fort Hayes. "Preheating—Welding—Normalizing," by C. J. Holslag, Electric Arc, Inc.

May 8th—Meeting—Battelle Memorial Institute. To be announced later—Col. G. F. Jenks, President, AMERICAN WELDING SOCIETY.

The Cleveland Section has opened a drive to double the membership of the unit during the year. Since September 1st, the Section has signed up 23 new members and has had one reinstatement. The membership committee is seeking to enlist the aid of the entire Cleveland membership in the campaign by mailing three application blanks to each.

Jan. 14th—"Welding of Copper and Brass" and film, "Story of Anaconda," by I. T. Hook, American Brass Company.

Feb. 11th—"Resistance Welding," by G. N. Sieger, President and General Manager, The S. M. S. Corporation.

## DETROIT

A "Stump the Experts" program was staged by the Detroit Section, on Friday, December 5th, at the Detroit Leland Hotel. Among the experts who answered questions from an audience of leading Detroit welding engineers were L. C. Bibber, Carnegie-Illinois Steel Co., on "Design for Welding and Arc Welding;" H. C. Cogan, National Electric Welding Machine Co., on "Resistance Welding;" H. W. McQuaid, Republic Steel Corp., on "Metallurgy of Welds;" M. R. Scott, The Linde Air Products Co., on "Flame Hardening and Strengthening, Oxy-Acetylene Welding;" and E. H. Vedder, Westinghouse Electric & Mfg. Co., on "Electronic Controls."

Programs for the coming months are as follows:

February 6th—"Unionmelt Welding in Defense Industries" by Mr. Ed. Morris, The Linde Air Products Company, Chicago, Ill. In the fabrication of heavy plates more especially, a new and most outstanding arc-welding process has come to the fore. This will be discussed in detail and motion pictures of the process and accomplishments will likewise be presented.

March 2nd—"Control in Spotwelding of Aluminum" by Paul H. Merriman, Glenn Martin Co., Baltimore, Md. This will be a joint meeting with the Society of Automotive Engineers. Mr. Merriman's paper, given at the Twenty-second Annual National Convention, A. W. S., was one of the outstanding presentations of the sessions. He discusses the over-all control, design, inspection, as well as production of this most timely subject matter. Because of the anticipated numbers at ending, it will be a closed meeting. Plan now to ask for invitations for your guests; we can and will entertain a limited number. *Note:* This will be a Monday Evening Meeting.

April 3rd—"Stored Energy Welding" by Mr. Maurice Sciaky, Sciaky Bros., Chicago, Ill. Mr. Sciaky will be assisted by C. W. Dodge, Chief Engineer. The development of stored energy welding is one of the revolutionary processes in aluminum fabrication. Mr. Sciaky's organization is one of the pioneers in this type of welding and his presentation will not only be interesting from the historical viewpoint, but also from the accomplishment viewpoint.

May 1st—"Past Chairmen's Night, Ladies' Night, House of Magic." Following the successful experience of last year, we will again honor those chairmen who have been responsible for the continuity of our activities. There will be no speeches as such, but there will be entertainment in the form of "House of Magic" and dancing which will prove of interest not only to our members, but also to our wives and sweethearts.

## LOS ANGELES

The Los Angeles Section had one of its

Meeting Los Angeles Section

most successful meetings on November 25th when they were guests of the Stoody Company at their Whittier plant. More than one hundred and fifteen members and guests were present and the lectures and motion pictures covering hard facing were extremely interesting and most instructive. The accompanying photograph of the group was taken at the Whittier Woman's Club House where the banquet was held prior to the meeting.

Later the entire group visited the Stoody Plant where the regular meeting was held. The principal speakers on the program were Mr. P. S. Wiswell, Divisional Sales Manager of Behr-Manning Corporation, Mr. Warren Turner of the Norton Company and Mr. J. R. Spence, General Sales Manager of the Stoody Company. The speakers were introduced by Mr. J. M. Gowing, Chairman of the Los Angeles Section.

Mr. Turner presented a film covering the uses of abrasives and grinding machinery in industry. Mr. Wiswell presented a film on the manufacture of paper and cloth abrasives which dealt with the methods of manufacturing the various types of sand paper, emery paper and allied products. Mr. Spence's talk dealt principally with the uses of hard-facing alloys in various industries, and included a series of natural color slides.

Some of the important local news units include announcements that the Western Pipe and Steel Company is now going to build a shipyard in the Southern California area, and have a contract to construct three ice breakers. This will mean there will be five major shipyards in the Los Angeles area, including the new ways being constructed by the Consolidated Steel Corp. at San Pedro.

Jan. 15th—"Pressure Vessels," "Aviation Welding of Light Gage Tubing."

Feb. 19th—"Aviation Manufacturing of Exhaust Collector Rings," " 'Union Melt' Applications."

March 19th—"Low Temperature Brazing," "Shipbuilding."

April 16th—"High Velocity Tensile Testing of Welds," "Aviation Welding of Large Jigs."

May 21st—"Resistance Welding."

June 18th—"Welding Dirt Moving Equipment," "Railroad Welding," "Aviation Inspection."

## MARYLAND

The Maryland Section held its second meeting of the season on November 20th. Mr. H. W. Peirce of the New York Shipbuilding Company was the speaker for the evening; his subject was "Welding in the Shipbuilding Industry." The talk was timely and very interesting to all who attended.

## MILWAUKEE

The regular monthly meeting of the Milwaukee Section was held on November 28th at the Cudworth Post—American Legion. Mr. Leo Teplow, Patent Attorney for the Allis-Chalmers Mfg. Co., gave an after-dinner talk on "Patents and the Engineer." Mr. W. F. Schmidt, Welding Supervisor, Rock Island Arsenal, gave the welding address on "Welding of Modern Artillery Vehicles."

The December meeting was held on the 19th, also at the Cudworth Post—American Legion. An after-dinner talk was given by Geoffrey Willoughby, Executive Secretary, Wisconsin, Council of Defense. Mr. Willoughby spoke on the Program of Civilian Defense. The welding address was given by Mr. R. W. Sternke, Chairman, Lakeside Bridge & Steel Co. Mr. Sternke spoke on "Training of Welding Operators." He was assisted by H. Pollei of the A. O. Smith Corporation, E. C. Brekelbaum of the Harnischfeger Corp., and P. M. Corp of the Heil Company.

## NEW YORK

The regular technical meeting of the New York Section was held on December 9, 1941, at the Engineering Societies Building, the program for the evening being furnished by General Electric Company. Mr. R. E. Bedworth of Westinghouse Electric and Manufacturing Company presided as Technical Chairman.

The technical paper for the meeting was presented by Mr. R. F. Wyer, welding engineer for General Electric Company, Schenectady, N. Y. Mr. Wyer selected as his subject, "Getting the Most from A.C. Welding," a subject that is most appropriate for this time, as Mr. Wyer pointed out.

After a description of some of the applications for which A.C. welding is of particular value, and touching on the importance of power savings, Mr. Wyer described briefly some of the advantages of A.C. welding, mainly the minimizing of the troublesome arc blow. Admitting the presence of factors that oppose the adoption of A.C. welding, he went on to analyze and remove the problems of operator fear and reluctance to accept this welding method.

Mr. Wyer explained the importance of power factor correction possible with the corrected A.C. welder. By means of slides showing tabular data and sketches, the importance of power factor correction in the industrial shop was brought out. Mr. Wyer also explained the proper methods for connecting A.C. welders into the power line, and the operation of such equipment to obtain maximum results.

Following Mr. Wyer's talk, the General Electric Company presented its "House of Magic" show under the supervision of Mr. W. A. Gluesing. This is the show which proved so popular at the New York World's Fair where it was seen by nearly 3,000,000 people. Demonstrations included the principles of the stroboscope, seeing sound by means of the cathode ray oscillograph, effects of ultra-violet light and visible light on fluorescent and phosphorescent materials, principles of electrically induced fever, photoelectric principles, and the controlling of electrical devices by means of sound.

Preceding the technical meeting, the second "get-together" dinner of the New York Section was held at Old Timer's Grill.

## NORTHERN NEW JERSEY

The December meeting of this Section was held on the 16th. Dinner in the Starlight Terrace of Essex House, Newark, preceded the meeting. An open discussion of welding subjects of direct interest to welding departments in this area was the program of the meeting. Questions previously submitted by members for this discussion were distributed to members so that they could come to the meeting prepared to discuss these problems.

A movie on the "Transportation of Large Diameter Welded Pressure Vessels" was presented through the courtesy of the M. W. Kellogg Company. This film

showed the use of inland waterways for the transport of welded vessels that are too large for shipping by ordinary methods.

## NORTHWEST

Mr. E. W. P. Smith, Consulting Engineer for The Lincoln Electric Co., spoke on "Procedure Control of Welding and Qualifications of Welding Operators" at the December 11th meeting of the Northwest Section held at the Coffman Memorial Union, University of Minnesota.

Programs for the coming months are as follows:

Jan. 15th—"Jigs and Fixtures," by R. W. Sternke, Lakeside Bridge & Steel Co.

Feb. 11th—"Welding in Defense," by H. L. Miller, Republic Steel Corp.

March 19th—"Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

April 9th—"Metallurgy of Welding," by E. C. Chapman, Combustion Eng. Co.

May 14th—Annual Meeting.

## OKLAHOMA CITY

The Oklahoma City Section met Thursday, December 4th, in the Biltmore Hotel, Oklahoma City. Fifty-two persons attended this meeting.

Mr. Tom C. Moore, senior student in Civil Engineering at the University of Oklahoma, presented a brief paper dealing with the history and design of the Tacoma Narrows Bridge. Following his talk, a two-reel picture of the actual failure of this bridge was shown.

The second speaker of the evening was Mr. Fred Lewis, who is Production Chief for the N. Y. A. Shops in the State of Oklahoma. Mr. Lewis' topic was "Welders Training for Defense in N. Y. A. Shops."

Mr. J. F. Brookes, Director of the School of Civil Engineering at the University of Oklahoma, assisted in the securing of the data which were used as a basis for Mr. Moore's talk, and was also present at the meeting with a large group of students from the University of Oklahoma.

Programs for coming meetings are as follows:

Feb. 5th—F. H. Dill, Welding Engineer, American Bridge Company, Ambridge, Pa. Subject: "Details of Welded Structures." Film to be presented through the courtesy of the Allegheny-Ludlum Steel Corporation. Subject: "There's a Job to Be Done."

March 5th—Still open. Dinner Meeting, Biltmore Hotel, 6:30 P.M.

April 9th—C. I. Lundgren, the Wichita Representative of the Taylor-Winfield Corporation of Warren, Ohio, who will speak on "Resistance Welding."

May 7th—Arthur N. Kugler, Mechanical Engineer, Applied Engineering Department, Air Reduction Sales Company, New York City, N. Y. Subject: "Designs of Jigs and Fixtures for Welding." Dinner Meeting, Biltmore Hotel, 6:30 P.M.

June 4th—Annual meeting, installation of officers and Dutch Lunch.

## PHILADELPHIA

The Philadelphia Section held another excellent meeting on Nov. 17th, followed by a lively discussion on codes and specifications.

The President of the Society, Col. G. F. Jenks, opened the meeting by outlining basic requirements for ordnance welding. The principal considerations are to design for single impact loads and to attain the maximum power with the least weight. Qualification procedures are set up to eliminate all possible stress raisers.

Mr. W. D. Halsey stressed the need for specifying results to be attained and not restricting too closely the methods of attaining them. He also urged that the A. W. S. qualification procedures be accepted and used wherever possible.

Mr. A. Amirikian outlined the transformation toward all-welded structures (both floating and shore) in the work coming under the direction of the Bureau of Yards and Docks. Every effort is being made to correlate their welding code for buildings with that of the A. W. S.

Mr. A. G. Bissell sounded the keynote of the evening when he told of the efforts now being made to have a common qualification procedure for all welders doing the same class of work.

The attendance again was exceptionally good and the Section was able to report the largest increase in membership in recent months.

There are at least twelve members now using their spare time to teach defense training courses in the Philadelphia area. In so doing, they are furthering the Society's aim to extend welding education, and at the same time are performing a valuable service to our Defense Industries.

Programs for coming meetings are as follows:

January 19th—"Arc Welding Electrodes," by Dr. John W. Miller, Reid-Avery Company.

February 16th—"Railway Welding." Speaker to be announced later.

March 16th—"More Important Fields for Gas Welding," by A. N. Kugler, Air Reduction Sales Co.

April 20th—"Structural Welding," by H. W. Lawson and W. F. Carson.

May 18th—"The Welding of High Pressure Piping." Speaker to be announced.

## PITTSBURGH

Two hundred and forty-five members and guests attended the November 19th meeting of the Pittsburgh Section to hear Wm. D. Halsey, Assistant Chief Engineer, Boiler Division of the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., give a most interesting discussion on the AMERICAN WELDING SOCIETY Standard Qualification Procedure.

It was a rare opportunity for the many welded-minded persons in this district to hear an authority discuss a question which at the present time is uppermost in the minds of those who have to do with welding.

Mr. Halsey covered his subject completely—taking in order the following points:

What is meant by Procedure Qualification?

Tests necessary to qualify Procedure.

What is meant by Operator Qualification?

Tests required to qualify an operator.

How to construct a simple device for testing operators.

What is the "Hartford Certificate?"

With the use of many slides and a blackboard, and in answering questions from the floor, Mr. Halsey left little of his subject uncovered and those present expressed themselves as having thoroughly appreciated the discussion.

## PUGET SOUND

The Puget Sound Section announces the election of the following officers for the coming year:

*Chairman*, Frank Bolte, Boeing Airplane Co.; *Vice-Chairman*, Ralph S. Russell, Hydraulic Supply Mfg. Co.; *Secretary-Treasurer*, John Nelson, Air Reduction Sales Co.

At the November 12th meeting at which the election of officers took place, Mr. A. J. Williamson of the Summerill Tubing Co. gave an interesting illustrated talk on the Metallurgical Effects of Welding.

## ROCHESTER

At the December 4th meeting Mr. E. E. Geisinger, Vice-President and Asst. Mgr. in charge of the Rochester Plant of The Pfaudler Company, gave an address on "The Manufacture of Chemical Equipment in Europe and the United States."

The February meeting will be held on the 5th. Mr. E. W. P. Smith of The Lincoln Electric Co. will speak on the subject, "Study of Stress Distribution by Means of Polarized Light." Motion pictures and slides will be used to illustrate this talk.

In October the Rochester Section started an educational program which is being given by members of the local Section. All lectures are at the River Campus at 7:45 P.M. The remaining lectures are as follows:

Jan. 15th—Discussion of Beads, Type, Sequence, Defects, Their Occurrence and Avoidance.

Feb. 12th—Stresses in Welds, Occurrence, Prevention and Relieving.

Feb. 19th—Welding Symbols.

Feb. 26th—Blueprint Reading.

Mar. 12th—Blueprint Reading.

Mar. 19th—Interpretation of Design.

Mar. 26th—Interpretation of Design.

Apr. 9th—Application.

Apr. 16th—Application.

There is no charge to members for this course. A fee of $5.00 is required of non-members.

## ST. LOUIS

A special Christmas Party was held at the Hotel Kingsway by the St. Louis Section on December 12th. Mr. R. D. Thomas, President of Arcos Corporation, presented an address on "Stainless Elec-

trodes for Welding and Hardening Steels." Refreshments were served.

Coming meetings of the St. Louis Section are as follows:

Feb. 12th—"The Elements of Welded Design," by L. C. Bibber, Carnegie-Illinois Steel Corp.

Mar. 13th—"Welded Steel Structures," by LaMotte Grover, Air Reduction Sales Co.

April 10th—"Machine Design," by John D. Gordon, Taylor-Winfield Corp.

May 8th—"Crater Cracks and Fish Eyes, Their Cause and Cure," by C. J. Holslag, Electric Arc Welding Co.

### SOUTH TEXAS

The South Texas Section held a regular meeting at the new Y. M. C. A. building in Houston, Tex., on December 1st. Qualification of welding operators in accordance with specifications of the U. S. Navy and Air Corps were discussed by Mr. J. Doyle, and by Mr. A. E. Wisler of the Hughes Tool Company, Houston, Tex. Mr. Doyle discussed various phases of operator qualification under Navy specifications for welding castings, and offered several specimens to show preparation of plate, removal of test pieces and method of testing. Mr. Wisler likewise demonstrated the welding technique in qualification for aircraft welding by showing specimens welded in various materials, and discussed some of the problems that evolve in training an operator to work on this class of production.

### WASHINGTON

The second regular meeting of the Washington Section of the AMERICAN WELDING SOCIETY was held on the evening of November 25, 1941.

The speaker, Mr. R. W. Clark, Welding Engineer of the General Electric Company at Schenectady, reviewed the fundamentals of welded joint design. In his introduction, Mr. Clark clearly stated that he had no personal ideas to convey but that he would discuss the five fundamental joints and their ramifications. It was pointed out that development in welding has grown up around many interested individuals and producing firms, which has resulted in various specific joint profiles which for the time and application seemed especially novel and suitable. In the beginning of welding, large included angles of bevel up to 90° were used. Mr. Clark illustrated the great amount of weld metal required for these joints as compared with those used today and showed slides illustrating the great deformation which occurs in the plate as a result of high stresses during the deposition of these large welds. Slides were also shown illustrating the correlation between various thicknesses of plate and the various types of joints. The higher strength and lower ductility characteristics of welds made with string beads as compared with those made by the weaving were illustrated. Complete and incomplete penetration was shown, showing that the latter was acceptable in many services though the joint design must be based upon facility of welding, accessibility and service of the weldment.

In conclusion, the speaker illustrated special expedients of joint design which arise in the electrical industry and in the design of steam turbines. The axiom drawn was that the welding laboratory, the welding engineer and the shop production men must work closely in order to effect scientifically correct and efficient production in these times of emergency.

### WESTERN NEW YORK

Regular November meeting was held November 12th at the Markeen Hotel with an extra large turnout to welcome the guest and speaker, Colonel Glen F. Jenks, President of the SOCIETY.

Colonel Jenks gave an interesting talk on "The Application of Welding in the Construction of Ordinance Material" which proved timely and instructive to his many friends in this section, and was particularly enjoyed for the lively discussion period at the end of the talk.

### YORK-CENTRAL PENNSYLVANIA

The first regular monthly meeting of the York-Central Section was held at the Engineers' Club, October 29, 1941. During the business session, the following officers were elected to serve for the current year: W. B. Lair, chairman; W. E. Hollingshead, vice-chairman; C. E. L. Kerchener, secretary; E. E. Rouscher, treasurer; E. J. Brady, L. H. Kemper, J. W. Hennessey, A. T. Light, C. C. Keyser and J. E. Harris, directors. At the close of the business meeting, Mr. Steven Smith, of the Air Reduction Corp., was introduced as guest speaker. His lecture on "Flame Hardening" included a discussion of many practical examples, all of which gave the lecture an educational as well as entertaining effect.

The November meeting was held Nov. 21, 1941. At the close of the short routine business session, Mr. F. G. Flocke, of the International Nickel Company, spoke on "Nickel, Monel and Inconel—Their Properties and Fabrication" covering the general properties of these materials, various methods of welding them and the forming and welding of nickel, Monel and Inconel-clad steels. Mr. Flocke used slides to illustrate his lecture, and an open discussion after he finished gave the audience an opportunity to ask questions which his lecture raised.

The York-Central Section is taking an active part in the establishment of an Electric Arc Welding School for National Defense in York, and as a result of this, the program committee has chosen a speaker for the December meeting whose lecture would be a timely one for this particular activity of the Section. The meeting was held on December 16th. Mr. O. T. Barnett, engineer of tests for the Metal and Thermit Corp., presented an illustrated lecture on "Procedure Control in Metallic Arc Welding" in which he reviewed the AMERICAN WELDING SOCIETY'S Specifications for iron and steel arc-welding electrodes and the physical properties that may be expected from electrodes in each grade of specification.

# Employment Service Bulletin

### SERVICES AVAILABLE

A-425. Experienced Supervisor of Welding desires position with going concern. Sales experience, procedure control of welding, general supervision of men. Qualified instructor on oxyacetylene and electric arc welding. Use of crater eliminator for plane welding, testing, inspection. All classes and kinds of welding and metals. Married, free to travel. Foreign employment given consideration. University education.

A-426. Welder, 2 years' practical experience, gas and electric welding. Welding 18 to 22 gage sheet metal, oxyacetylene. Desires to add to knowledge by working on off Saturdays on heavier material either arc or gas, with or without compensation.

A-427. Welder with 12 years' experience in custom welding shop, gas and electric welding. Have had several classes instituted by different welding companies. American born. 38 years of age. Willing to go anywhere.

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### WAR DEPARTMENT SEEKS DEFENSE PRODUCTION INSPECTORS

The latest examination announcement to come from the U. S. Civil Service Commission is for Inspector positions in the Defense Production Protective Service of the War Department. Salaries range from $2600 to $5600 a year. Applications will be rated as soon as possible after receipt at the U. S. Civil Service Commission, Washington, D. C.

The title "Inspector, Defense Production Protective Service" implies the urgency of this examination. These inspectors will be responsible for making recommendations to prevent interruptions or delays in the production and delivery of all types of defense material when these interruptions may be caused by major accidents, explosion or other hazards inherent in manufacturing plants. No written test will be given. Applicants will be rated on their education, experience and personal qualifications. The requirements are as follows:

(*a*) General experience in performing inspectional and professional engineering advisory services for manufacturers, as inspector in a property insurance rating bureau, as plant protection supervisor or master mechanic in a large industrial establishment, or as professional engineer specializing in plant protection work.

(*b*) Chief and principal inspectors ($5600 and $4600 a year) are also required to have had responsible administrative experience not necessarily in connection with plant protection inspections.

Provision is made for substituting appropriate college study for part of the prescribed experience.